Volume 29 SEPTEMBER, 1922 Number 1

MACHINERY

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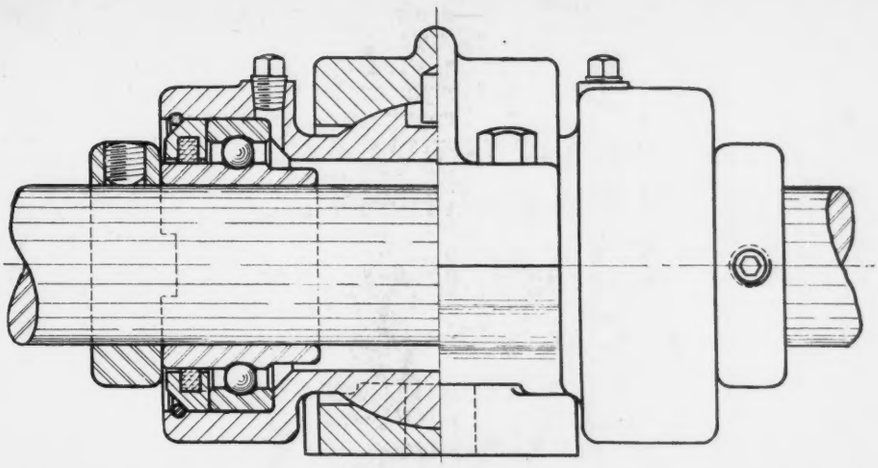

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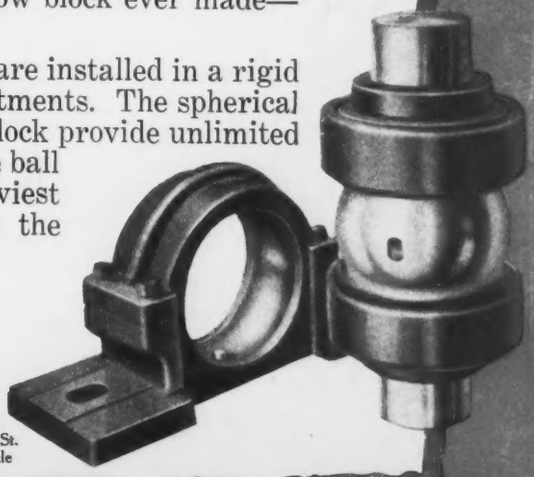

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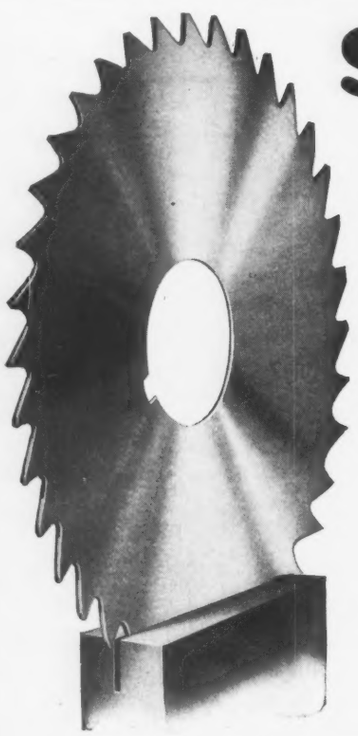

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VOLUME 29

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CIRCULATION FOR AUGUST, 1922, 19,000 COPIES

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Articles on the Mechanical Transmission of Power, Ball Bearings in Textile Mills, Flexible Couplings, Babbitt Bearing Metal, Inspecting Taper Rollers by Machine—Gaging and Sorting at the Rate of 3000 Rollers per Hour—These are some of the principal features in October MACHINERY.

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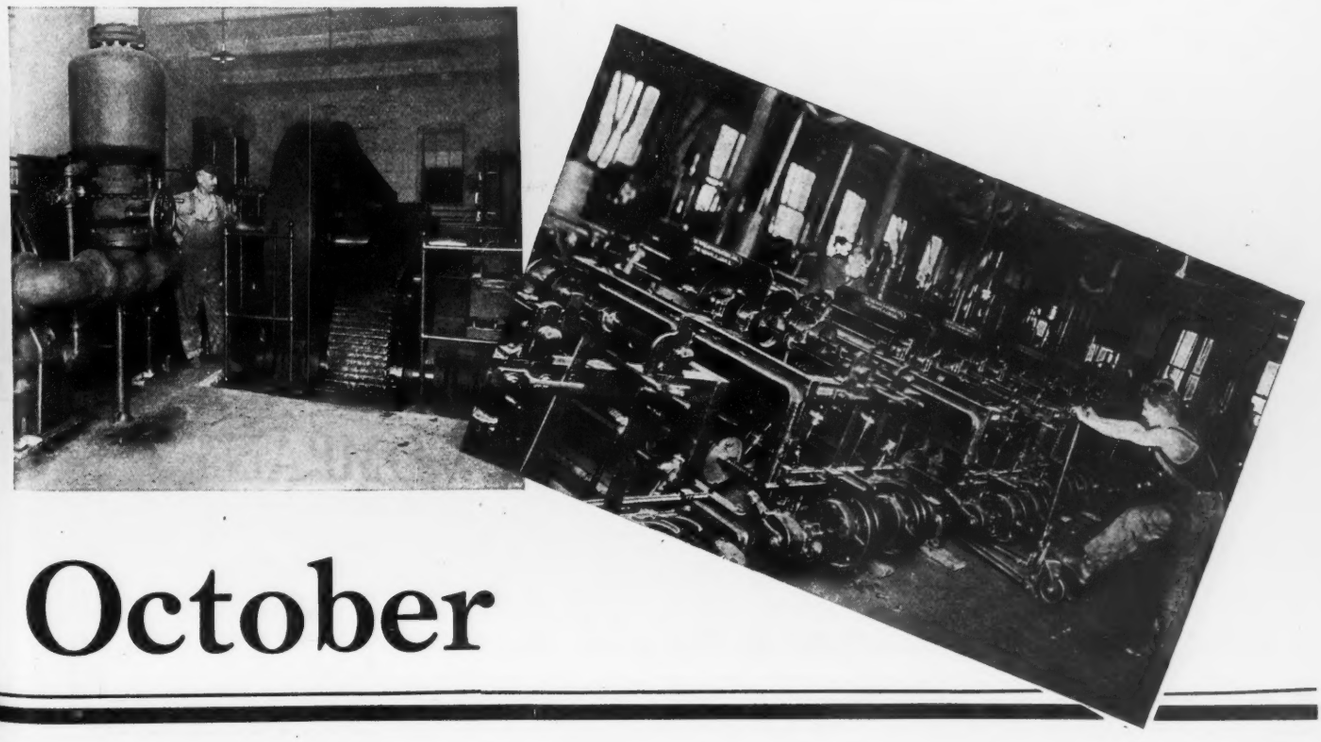
The leading editorial article will be "Mechanical Transmission of Power"—a review of the various means used for power transmission, belting, chain drives and gearing. "Babbitt Bearing Metal" and "The Design and Application of Flexible Couplings" will be found especially valuable—each was written by an expert in his field. A machine that automatically gages and sorts taper rollers for bearings at 3000 an hour is described. Other pertinent articles are scheduled. Altogether October MACHINERY will be distinctly worth while—don't miss it.



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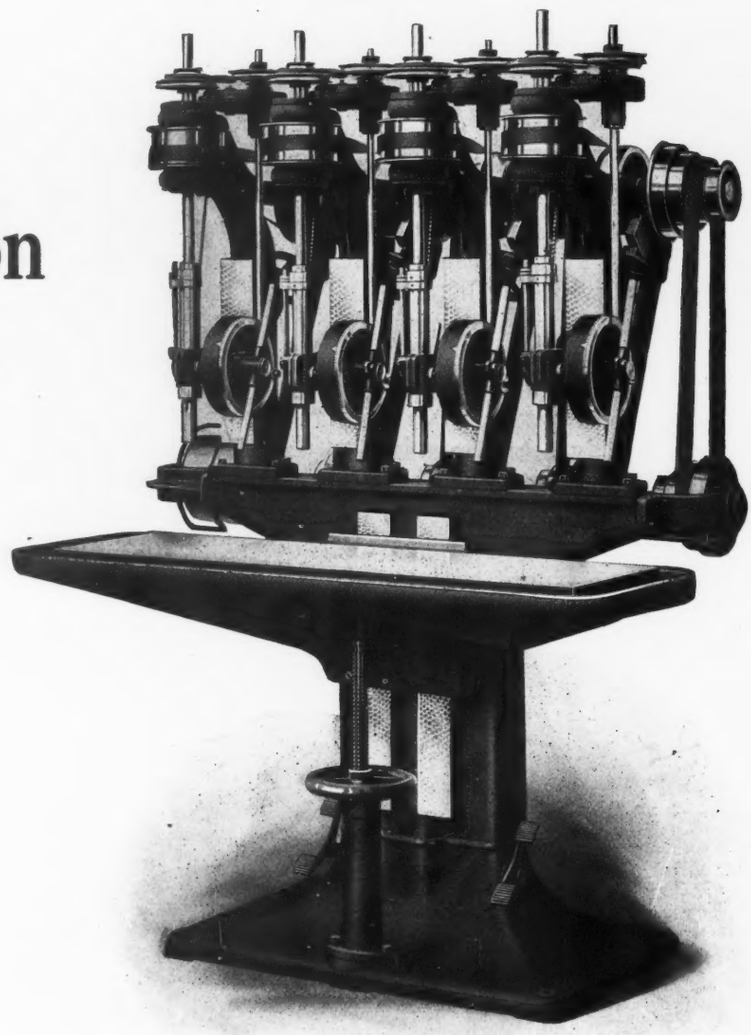

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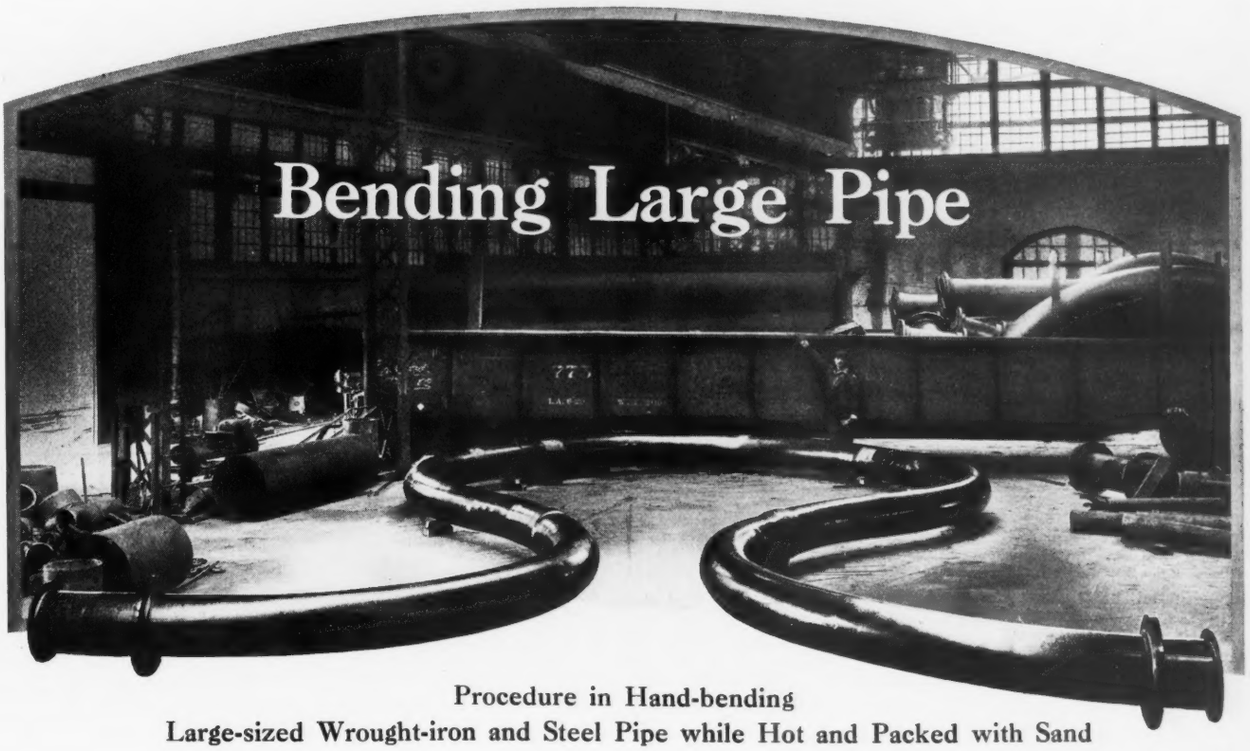
SEPTEMBER MACHINERY 1922

Bending Large Pipe



Procedure in Hand-bending
Large-sized Wrought-iron and Steel Pipe while Hot and Packed with Sand

By CHARLES O. HERB

BENDING large wrought-iron and steel pipe is an art in which the success of the operation depends almost entirely upon the man in charge. The pipe is bent while hot, and therefore close attention and quick action are required to prevent flattening or bulging on the inside of the bend, fracture on the outside, the opening up of seams on butt-welded pipe, and other difficulties likely to arise while the work is in progress. Considerable experience is also necessary to properly supervise the steps preceding the actual bending. The present article mentions briefly the advantages of pipe bends over steel and cast-iron fittings when the direction of the pipe line must be altered, and describes the tools used and methods followed in bending large pipe by hand. Tables give the minimum and advisable radii for pipe bends and other information of value to the plant engineer. The illustrations, with the exception of Fig. 7, were obtained at the plant of the M. J. Dougherty Co., Philadelphia, Pa., and represent the practice of this company in bending pipe from 6 to 30 inches in nominal size.

In modern industrial plants, pipe bends are greatly preferred to steel or cast-iron fittings for a number of reasons. In the first place, the use of bands reduces the number of joints and eliminates much of the leakage common to fittings. U-bends also serve conveniently in long steam lines as a means of compensating for expansion and contraction of the pipe which result from changes in its temperature. Again, in conveying steam or fluids through piping, the velocity is reduced because of the friction between the fluid and the pipe. In the case of steam lines a high friction causes a greater percentage of condensation in the line and a drop in steam pressure. This is especially a vital factor about coal mines where steam is frequently conveyed 3000 feet from the boiler house to its place of application. Fittings contribute considerably to this reduction in velocity and pressure because of the friction caused by their necessarily small radii. It has been proved that the resistance met with in a 12-inch 90-degree elbow fitting is equivalent to the resistance offered by 40 feet of straight-length pipe of the same size. With pipe bends, however, the radii may be much larger than with fittings, and friction may be reduced to the minimum. Finally, pipe bends permit a cheaper and safer installation than fittings and are much neater.

Pipe up to about 4 inches in nominal size can be bent while cold by employing machines designed for the purpose, but larger sizes must be heated for the operation. The general practice is to bend such pipe on a large table, employing a winch to pull the sand-packed, heated pipe to the required shape around blocks or pins. A great deal of skill is required to bend large pipe without obtaining any of the undesirable results common to this work.

Design of Bending Table, Blocks, Shoes, and Pins

The common practice is to bend heated pipe to shape around either shoes or pins located on a large table to suit the radius to which the pipe is to be bent. The two bending tables of the M. J. Dougherty Co. are 20 feet square, being constructed of two semi-steel castings, 9 inches thick. Each table weighs approximately 70 tons. The two sections are held together by fifteen 2-inch bolts and five steel forged keys which are dovetailed at both ends. In assembling the sections, the keys were heated and shrunk into dovetailed slots cored in the sections, thus insuring a rigid connection. The keys extend the full depth of the table and their

cross-section is 12 inches long and 4 inches wide between the dovetails. The location of these keys may be observed in Fig. 2 which shows plan and end views of the table. The top and adjoining surfaces of the two sections are finished. The table is supported by three long concrete piers, one at each end and one at the center, to which it is anchored by two-inch foundation bolts. The working surface of the table is about 3½ feet above the floor level.

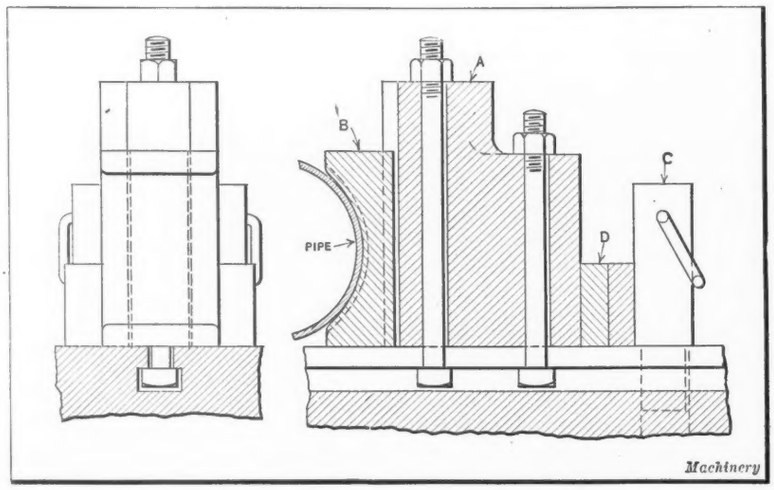


Fig. 1. A Bending Shoe and Method of attaching it to the Table shown in Fig. 2

The table has a hole at *A* from which a series of T-slots radiate to three sides of the table. These T-slots are 22½ degrees apart and serve as a means of attaching to the table, blocks against which the shoes previously mentioned are abutted. In back of hole *A* several parallel T-slots extend across the table. Spaced between all T-slots are a series of 3½-inch holes which receive the table pins. In addition to using these pins as an upright against which the pipe may be bent, they are also employed to prevent one end of the pipe from moving during an operation and to provide additional support to the blocks and shoes. The portion of these pins which extends above the table surface is about 4 inches in diameter.

The method of arranging a block and shoe for a job is illustrated in Fig. 1. Block *A* is clamped to the table the necessary distance from the center of hole *A*, Fig. 2, so that after shoe *B* is slid into place, the distance from the center of the hole to the bending surface of the shoe will equal the radius to which the pipe is to be bent minus one-half the outside diameter of the pipe, when the radius is given to the center line of the pipe. The shoe is merely butted against the block, and is prevented from moving sidewise by a tongue which engages the walls of a recess on the block. Two table pins *C* relieve the block clamping bolts from overstrain.

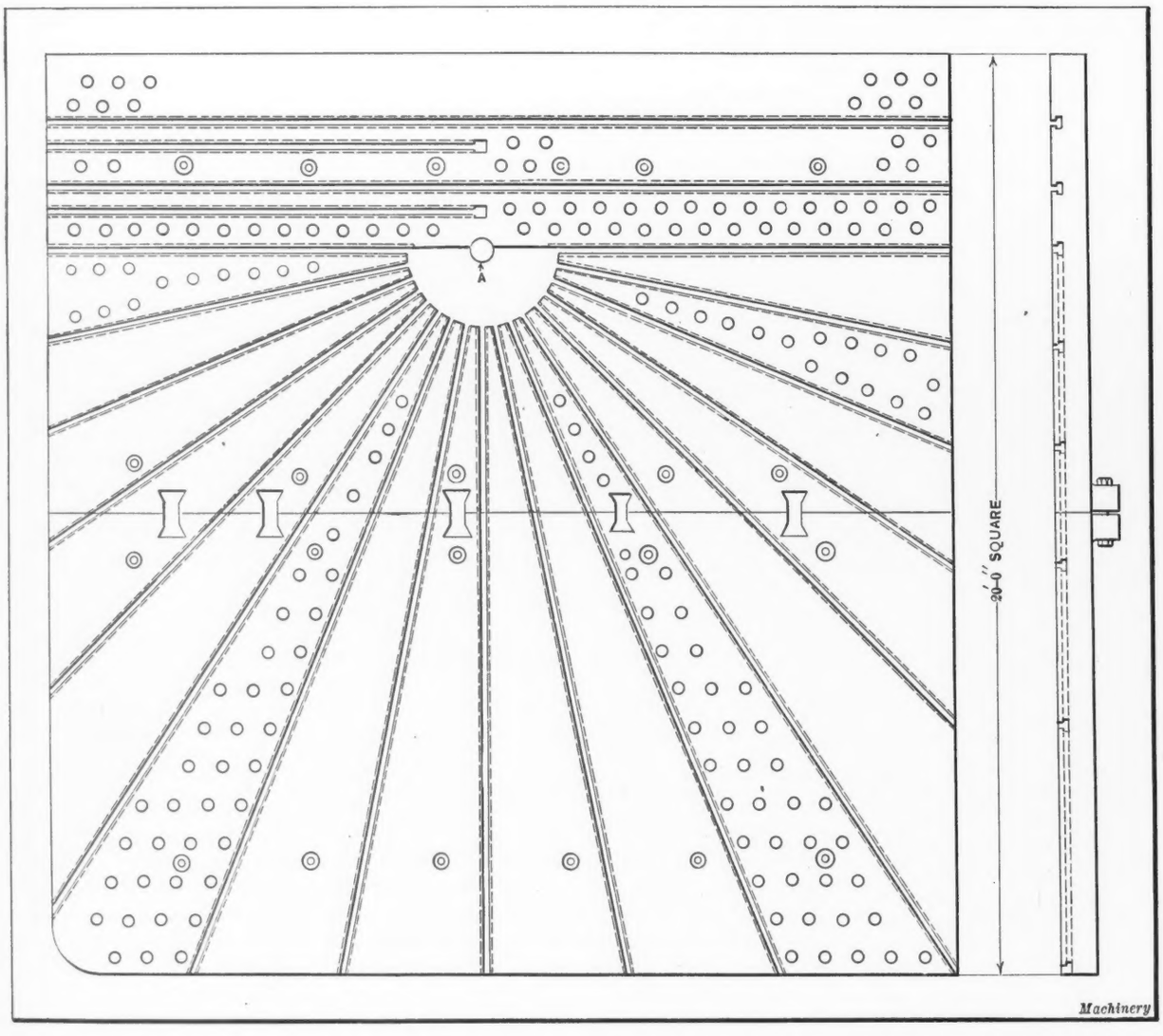


Fig. 2. Plan and End Views of a 20-foot Square Bending Table, showing the Lay-out of T-slots, Pin-holes, and Assembly Keys

Because of the table pin-holes being at the side of the T-slots, it is generally necessary to place spacers between the pins and block *A*, as shown at *D*. A forged handle on the table pins facilitates their use.

The shoes are made in various sizes from 4¾ to 23 inches in height to accommodate the bending of pipe of any size up to 30-inch. The curved bending surface of the smallest sized shoe has a radius of 2⅜ inches and that of the largest, a radius of 12¼ inches. Only one size of block is used with the entire equipment of shoes, the block being 18 inches in overall height. Both blocks and shoes are iron castings. When large quantities of pipe, 6 inches or less in nominal size, are to be bent to the same radius, it is more economical to provide forms cast to the shape of the desired bend, instead of utilizing the shoes. Such forms may be quickly set up for a bending operation.

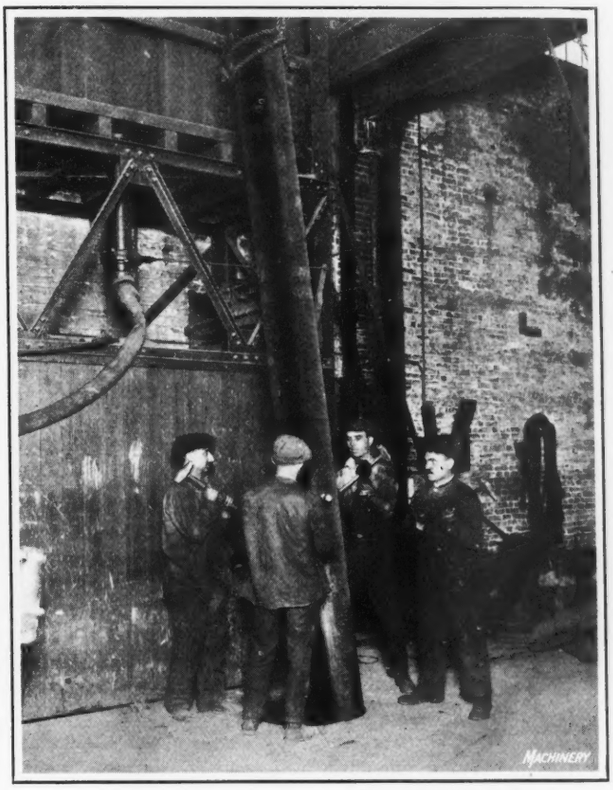


Fig. 3. Packing Sand in a Pipe by hammering on the Outside while the Pipe is held in a Vertical Position

The chief tendencies of a pipe while being bent are to flatten or buckle along the inside of the curve. These tendencies are guarded against by filling the pipe with kiln-dried sand and packing the sand so thoroughly that the pipe wall cannot readily flatten or buckle because of the resistance offered by the sand. Preparatory to filling the pipe with sand, a cap or plug is inserted in one end and secured in place by means of radially disposed set-screws. The pipes are filled at one end of the shop where the roof is 60 feet above the floor level and where a pit extends 46 feet below the floor. The pipe is raised into a vertical position and lowered into the pit a sufficient amount to permit the pipe to be filled through using a rubber hose connected to the under side of a 25-ton sand bin erected along the wall.

When the pipe has been filled it is raised until the bottom end is almost level with the floor, after which the sand is packed by hammering on the pipe. An automatic air-operated mechanism which is adjustable to suit various sizes of pipe, has recenty been developed in this plant for hammering; it was formerly done by hand, however, as shown in Fig. 3 in which a 12-inch pipe 20 feet long is being packed by four men. This practice is still followed in many plants. After one section of the pipe has been hammered a sufficient amount, the pipe is lowered 2 or 3 feet. This procedure is followed until the pipe has been hammered its entire length. The amount of hammering, of course, depends upon the diameter of the pipe, that illustrated being hammered for about one hour. It is obviously a slow, tedious job, and the value of the automatic device mentioned may

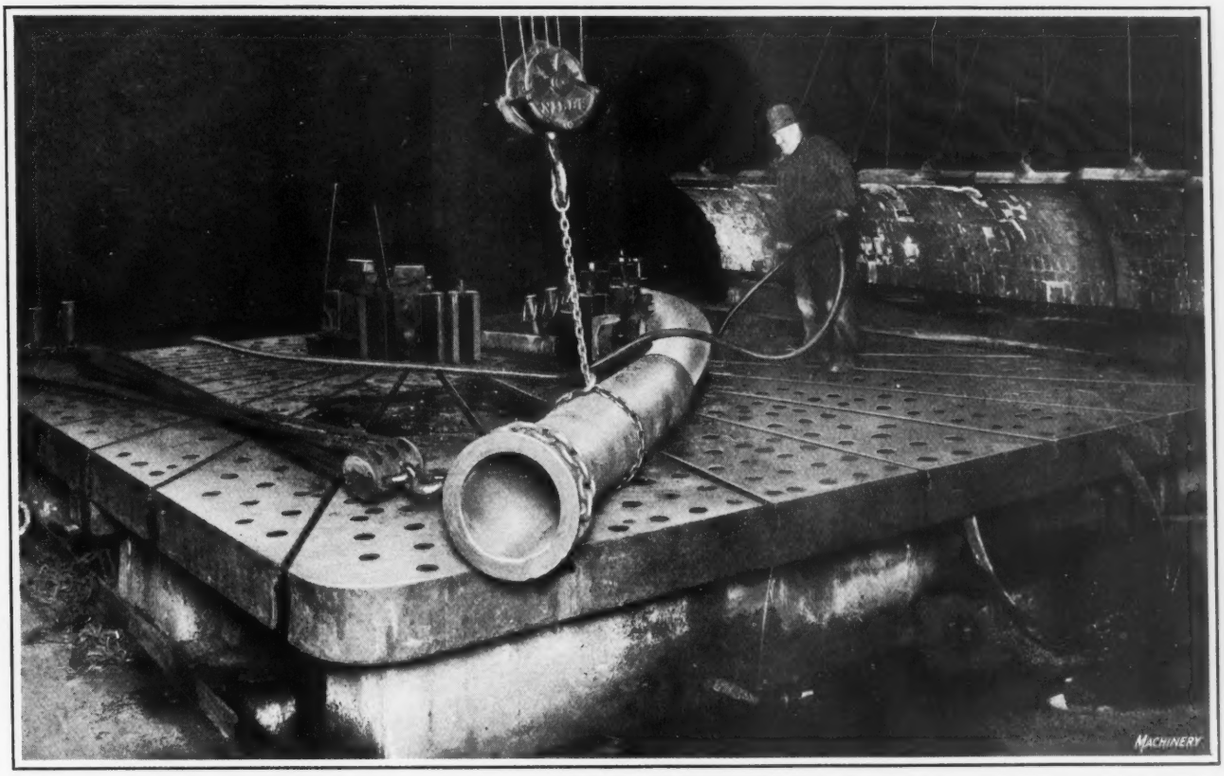


Fig. 4. Bending a 12-inch Pipe 20 Feet Long by employing a Winch to pull the Pipe against Shoes set to the Required Radius of the Bend

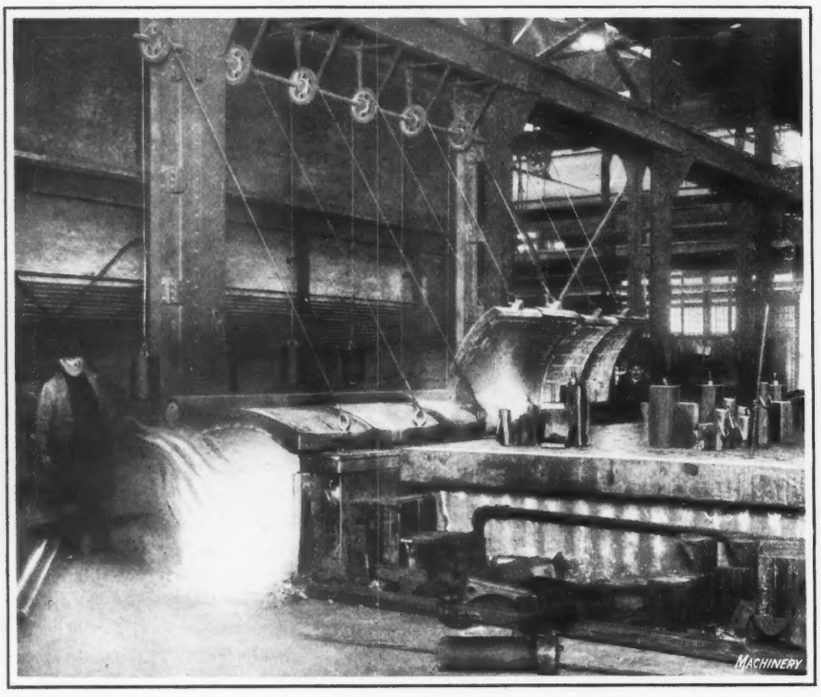


Fig. 5. Heating Pipes to a Cherry-red Color in an Oil Furnace constructed along One Side of the Bending Table

easily be appreciated. After the packing of the pipe has been completed, about a 2-inch covering of clay is made over the sand at the exposed end of the pipe and a cap fitted over the clay in the same manner as at the opposite end. Either a five- or a ten-ton hoist is used for handling the pipe during its filling and packing, the hoist employed for a given job depending on the weight of the pipe.

Heating to the Necessary Temperature

After the pipe end has been sealed, the distance from one end to the point where the bend is to commence is measured and a yellow band painted around the pipe at that location. A similar band is also painted at the point where the bend is to end. These bands later aid in placing the pipe correctly on the table relative to the bending shoes and in the bending step. The pipe is next lifted by an overhead traveling crane and transferred to the oil furnace constructed along one side of the table as illustrated in Fig. 5 which shows two pipes being heated. The furnace has eight burners which project flames transversely beneath the pipe. Only those burners are lighted whose flames will play on the section of the pipe to be bent. Eight counterweighted doors lined with firebrick provide for closing the top of the furnace over the section of the pipe to be heated. When closed, these doors cause the flame to circle around the pipe. The doors over the section of the pipe not to be bent are left raised to permit the flames to escape. The pipe remains in the furnace until it has been brought to a cherry-red color. The fuel oil is atomized by compressed air delivered from a tank extending along the rear wall of the furnace.

The Bending Operation

When the pipe has reached the proper temperature, the burners are shut off, the furnace doors raised and the pipe lifted to the bending table by means of the overhead crane. That end of the pipe which has not been heated is next secured between table pins and blocks. Bending shoes had been previously arranged for bending the pipe shown in the furnace in Fig. 5 to a radius of 5 feet 10 inches. A larger diameter pipe of short length and having an integral flanged end was slipped over the free end of this pipe as shown in Fig. 4 and, by means of a short length of chain, tackle blocks and rope, connected to a 19-horsepower motor-driven winch or "niggerhead." The bending is accomplished by hauling up on the rope connected to the winch. The operation was about half completed at the time the photograph reproduced in Fig. 4 was taken. This portion of the operation must be conducted with extreme care because if the pipe is bent too quickly, flattening or buckling will result in spite of the sand filling, or the wall of the pipe will be excessively strained along the outside of the bend, causing cracks. During the operation, one end of the pipe is lifted slightly above the surface of the table by means of the crane to lessen the load on the winch.

Before commencing the operation, water from a hose is squirted on the side of the pipe which later forms the outside of the bend, until it becomes blue. This insures that the pipe will compress along the inside of the curve rather than stretch along the outside. This cooling also insures a better support of the pipe wall by the sand filling, because it causes the internal diameter of the pipe to be slightly reduced. If the wall at the outside of the curve is permitted to stretch, the diameter will be slightly increased. However, if the pipe is cooled too much, buckles will result when

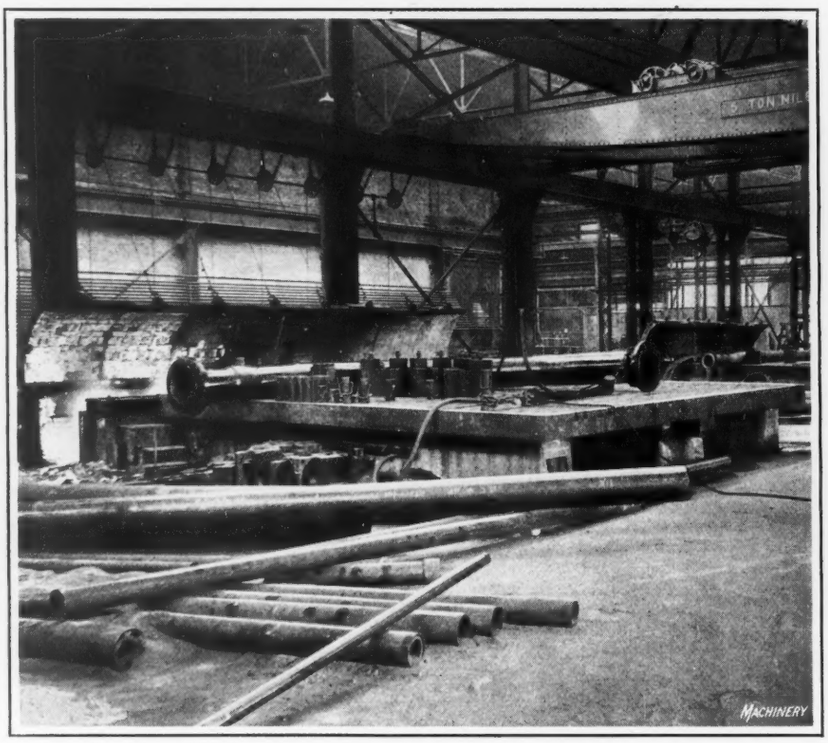


Fig. 6. View of Furnace and Table, with Completed 90-degree Bend lying on the Table

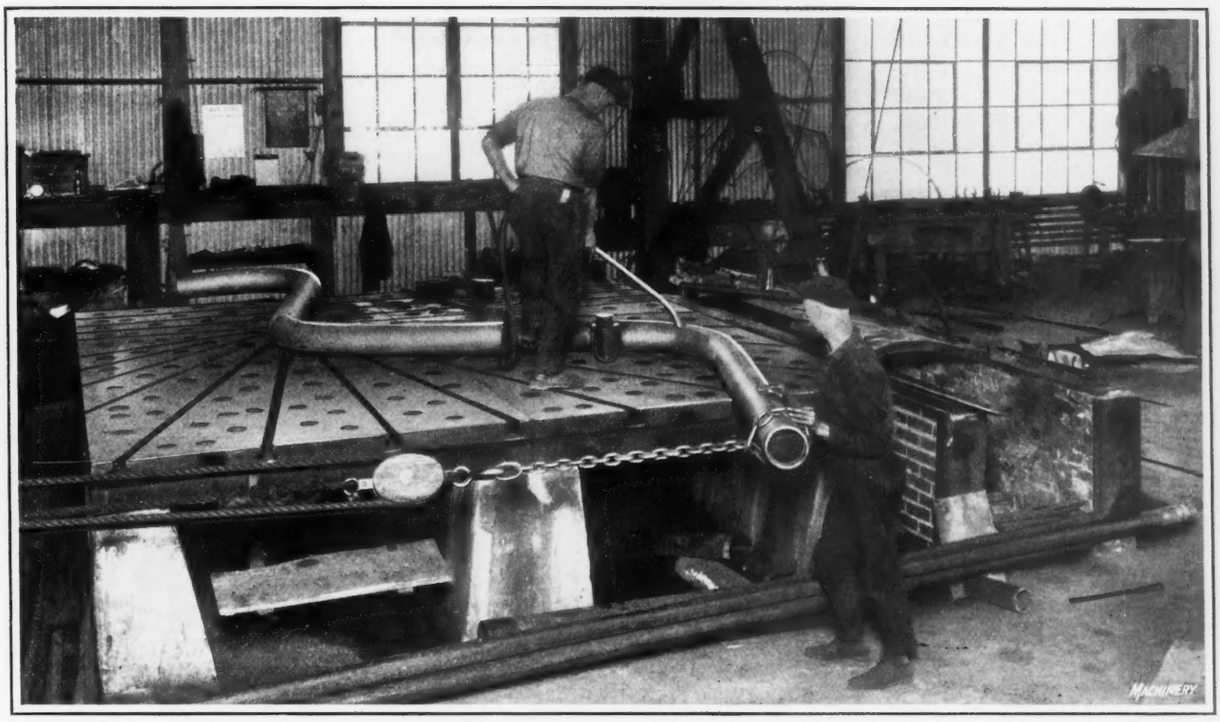


Fig. 7. Three 90-degree Bends being made in a 6-inch Pipe heated locally and bent by holding the Pipe between Two Pins

the attempt is made to bend the pipe. The cooled section is, of course, quickly reheated by the sand and the adjoining uncooled pipe wall.

While the bending is in progress the man in charge of the job remains on the table and holds the hose of running water in readiness. If the pipe bends too quickly at any point he signals the operator of the winch to stop hauling the rope and applies water at the threatened point to cool it momentarily. This work must be done quickly, otherwise the pipe will become too cold for the bending to be accomplished satisfactorily. The pipe in the illustration Fig. 4 was bent to an angle of 90 degrees. In Fig. 6 a finished 90-degree elbow is shown on the bending table.

Making Complicated Bends

In view of the methods followed in bending pipe, it would seem difficult to perform an operation with any degree of accuracy; yet an experienced man can bend large pipe to within ¼ and even ⅛ inch of the required dimensions. Bends of 90 and 180 degrees are, of course, simpler to produce to specifications than double bends. For bends of the latter class, a templet is usually made from about ⅜-inch round stock to follow the outline that the axis of the pipe will assume when bent. Then, during the bending operation, this templet is used to determine when the pipe has been brought to the desired shape. On double bends care is

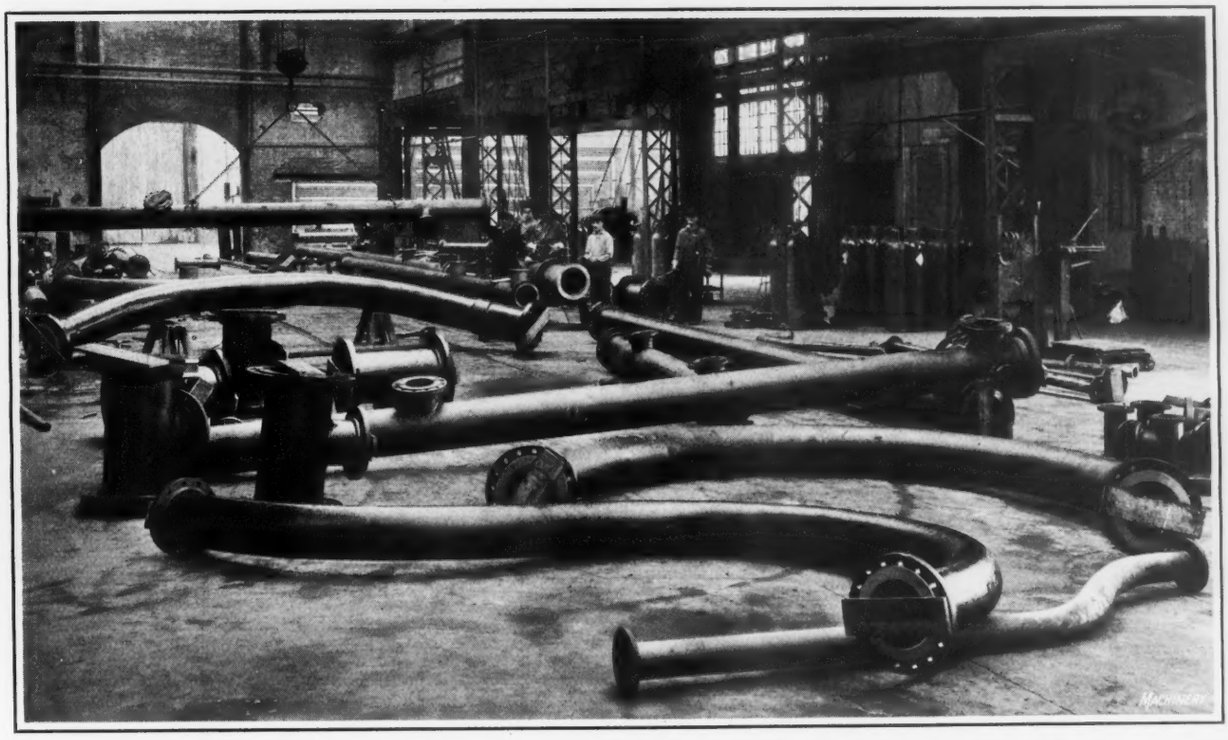


Fig. 8. Examples of Bends having Square-lap Van Stone Flanges and Straight Pipes having Welded Side Outlets

taken to bend the curves to the proper radii, even though the distance between the radii centers is only approximate. Such discrepancies are later rectified by heating the straight section of pipe between the two curves by means of a portable oil-burning equipment and then again bending the pipe slightly as required. The yellow bands painted around the pipe prior to heating facilitates the making of double bends.

An interesting operation consisting of putting three 90-degree bends in a 6-inch pipe to radii of 30 inches, is illustrated in Fig. 7. This photograph was taken at the plant of the Standard Piping and Fitting Co., 30th and Race Sts., Philadelphia, Pa. The pipe was held between two table pins with suitable shoes placed between the pins and the pipe. The work was heated locally after being packed with sand and bent by employing a winch as explained in connection with the previous example. The pipe in this case was bent to specifications by reference to a templet. If it were necessary to make an offset in a plane other than that in which the bends are made, it could be accomplished by clamping the pipe to the table, and by means of a hoist, pulling up the section of the pipe to be raised. A pneumatic hoist attached to an I-beam trolley is used in some plants for this purpose.

The heading illustration shows an expansion bend produced at the plant of the M. J. Dougherty Co. This example consists of five sections of 16-inch extra strong pipe welded together after having been bent to shape. The over-all height is 38 feet and the distance from face to face of the flanges, 24 feet. Other interesting examples of pipe work at the same plant are illustrated in Fig. 8. Holes have been cut into the walls of some of these examples and outlets welded into place. All these examples have a square-lapped Van Stone joint. In producing this joint the steel flange is slipped over the pipe end, after which the end is heated and forced back by special machines.

TABLE 1. MINIMUM AND ADVISABLE RADII FOR PIPE BENDS; LENGTH NECESSARY FOR 90-DEGREE BENDS; AND DESIRABLE STRAIGHT LENGTH AT ENDS

Nominal Size of Pipe, Inches	Standard or Full Weight Pipe				Extra Strong Pipe		Expansion Bends		Length of Straight Section for Fitting
	Min. Radius	Length for 90-deg. Bend	Advisable Radius	Length for 90-deg. Bend	Min. Radius	Length for 90-deg. Bend	Advisable Radius	Length for 90-deg. Bend	
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
1	4	6¼	5	7⅞	2½	3 15/16	8	1 0½	2½
1¼	5	7⅞	6	9 7/16	3	4¾	10	1 3¾	2¾
1½	6	9 7/16	8	1 0½	4	6¼	1 0	1 6⅞	3
2	7	11	10	1 3¾	5	7⅞	1 3	1 11½	3½
2½	8	1 0½	1 0	1 6⅞	6	9 7/16	1 6	2 4¼	4
3	10	1 3¾	1 3	1 11½	8	1 0½	1 9	2 9	4½
3½	1 0	1 6⅞	1 6	2 4¼	10	1 3¾	2 0	3 1¾	5
4	1 3	1 11½	1 9	2 9	1 0	1 6⅞	2 3	3 6⅜	5½
4½	1 6	2 4¼	2 0	3 1¾	1 2	1 10	2 6	3 11⅛	6
5	1 9	2 9	2 3	3 6⅜	1 3	1 11½	2 9	4 3⅞	6½
6	2 0	3 1¾	2 6	3 11⅛	1 9	2 9	3 3	5 1¼	7
7	2 3	3 6⅜	2 9	4 3⅞	2 0	3 1¾	3 9	5 10¾	8
8	2 9	4 3⅞	3 3	5 1¼	2 3	3 6⅜	4 3	6 8⅛	9
9	3 3	5 1¼	3 9	5 10¾	2 9	4 3⅞	4 9	7 5½	10
10	3 9	5 10¾	4 3	6 8⅛	3 3	5 1¼	5 6	8 7⅝	1 0
11	4 3	6 8⅛	4 9	7 5½	3 9	5 10¾	6 0	9 5⅛	1 1
12	4 9	7 5½	5 3	8 3	4 3	6 8⅛	6 6	10 2½	1 2
14	6 0	9 5⅛	6 6	10 2½	5 6	8 7⅝	7 6	11 9⅜	1 4
15	6 6	10 2½	7 0	11 0	6 0	9 5⅛	8 6	13 4¼	1 5
16	7 0	11 0	7 6	11 9⅜	6 6	10 2½	9 0	14 1⅝	1 6
18	7 9	12 2⅛	8 3	12 11½	7 3	11 4⅝	.....	.....	1 6
20	9 0	14 1⅝	9 6	14 11	8 3	12 11½	.....	.....	1 6
22	....	.....	.....	.....	9 3	14 6⅜	.....	.....	1 6
24	....	.....	.....	.....	10 0	15 8½	.....	.....	1 6

Machinery

Bending Limitations

Pipe of large sizes should be bent to as long radii as conditions will permit in order to reduce the possibility of buckling or flattening to the minimum. A suitable radius for all pipe from 4 to 20 inches in diameter inclusive, is six times the diameter of the pipe. This is known as the "standard radius," and bends made to a radius of this proportion are very satisfactory. Pipe from 4 to 12 inches, however, can be bent successfully to a radius equal to three times the diameter, and sizes above 12 inches to a radius equal to four times the diameter. The radii may be even smaller than the ratios that are mentioned, but it is not advisable to make small bends.

The length of pipe allowed for a curve should equal the length of the arc which will be formed by the center line of the pipe. Thus, if the radius to the center of a 90-degree bend is to be 48 inches, the length of pipe that should be allowed for the curve would equal $0.7854 \times 2 \times 48$ or 6 feet 3⅜ inches. To this length, of course, would need to be added the length of straight section or tangent at each end of the bend. This straight section should at least equal the diameter of the pipe, and with pipe 10 inches or larger in size it is advisable to make the straight section one and one-half times the diameter. If the straight section at the end of the pipe is less than specified, the pipe is liable to flatten at the end, a condition that will prevent the tight fitting of a screwed-on flange and cause leakage.

Table 1 presents the minimum and advisable radii to which standard or full-weight wrought-iron and steel pipe should be bent; the minimum radii for extra strong pipe; the advisable radii for bends to be used to take up expansion and contraction of steam lines; the length of pipe necessary for 90-degree bends of the radii given; the minimum straight section length that should

TABLE 2. THICKNESS OR WEIGHT OF PIPE FOR EXPANSION BENDS FOR VARIOUS PRESSURES

Working Pressure, Pounds per Square Inch	Nominal Pipe Diameter, Inches	Radius of Bend	Thickness or Weight of Pipe
Up to 125 Pounds	7 and under	4 to 5 times dia.	Extra strong
	8 and over	4 to 5 times dia.	½ inch
	7 and under	Over 5 times dia.	Standard weight
	8	Over 5 times dia.	28.55 pounds per foot
	10	Over 5 times dia.	40.48 pounds per foot
	12	Over 5 times dia.	49.56 pounds per foot
	14 to 16	Over 5 times dia.	5/16 inch
	18 to 22	Over 5 times dia.	⅜ inch
	24 to 30	Over 5 times dia.	7/16 inch
125 to 250 Pounds	7 and under	4 to 6 times dia.	Extra strong
	8 and over	4 to 6 times dia.	½ inch
	7 and under	Over 6 times dia.	Standard weight
	8	Over 6 times dia.	28.55 pounds per foot
	10	Over 6 times dia.	40.48 pounds per foot
	12	Over 6 times dia.	49.56 pounds per foot
	14 to 16	Over 6 times dia.	⅜ inch
	18 to 22	Over 6 times dia.	7/16 inch
	24 to 30	Over 6 times dia.	½ inch
250 to 350 Lbs.	7 and under	4 times dia. and over	Extra strong
	8 and over	4 times dia. and over	½ inch

Machinery

be furnished at each end of a pipe. The length of pipe necessary for forming a 180-degree bend to any of the radii given, may be determined by doubling the length required for a 90-degree bend of the same radius. Each radius is given to the center of the pipe. This table has been compiled from the data of large concerns making a specialty of pipe bending and may thus be considered as safe to work to.

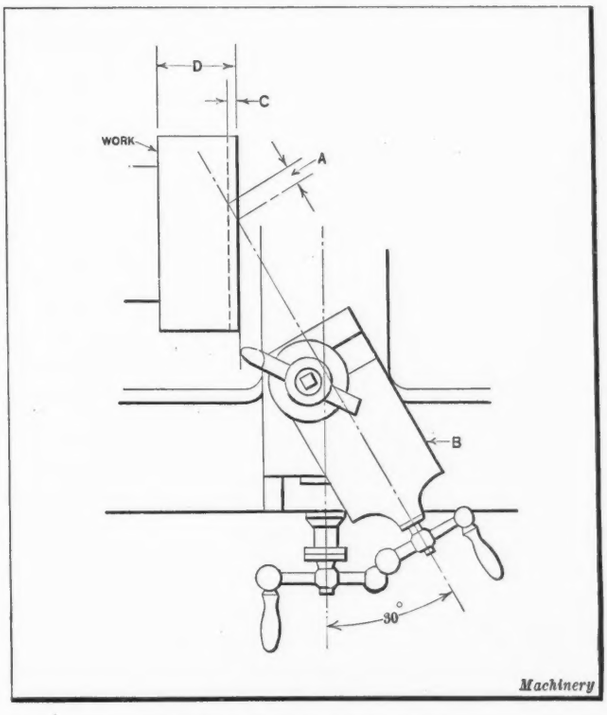
The advisable radii for expansion bends are somewhat greater than the advisable radii for full-weight or standard pipe. Bends made to these dimensions will have the desired expansive value. If they are much less, the bends will have practically no expansive value. Bends in expansion should have the largest radii possible under prevailing conditions. Tests conducted by the Crane Co., Chicago, Ill., showed that expansion U-bends made from extra-strong pipe have practically the same expansive value as U-bends made from standard or full-weight pipe. An important factor to be considered in designing pipe bends for expansion lines is the weight per foot of the pipe to be used. This depends upon the working pressure to which the line will be subjected. Table 2 gives either the desirable weight of pipe, or its wall thickness, for working pressures up to 350 pounds per square inch. This table is based on experiments made by the Crane Co.

* * *

SETTING TOOL FOR FACING CUT

By H. P. FOOTE

If the compound rest of a lathe is set at an angle of 30 degrees, as indicated in the accompanying illustration, the distance *A* through which the slide *B* must be moved to take a facing cut of depth *C* is twice as great as it would be if the compound rest were set parallel with the lathe spindle. It is also obvious that *A* is equal to twice the distance through which the carriage would have to be moved to the left in order to obtain the same result.



Method of setting Tool for Facing Cut

Now assume that a facing cut has been taken, and on measuring with a micrometer, dimension *D* is found to be within 0.0005 inch of the desired thickness. In order to remove 0.0005 inch of metal from the face of the work, it is necessary, theoretically at least, to advance the rest on which the tool is mounted exactly 0.001 inch instead of 0.0005 inch. Thus by having the compound rest set at a 30-degree angle we may use the 0.001-inch graduation of the compound rest feed-screw in setting the tool over for a cut of only 0.0005 inch.

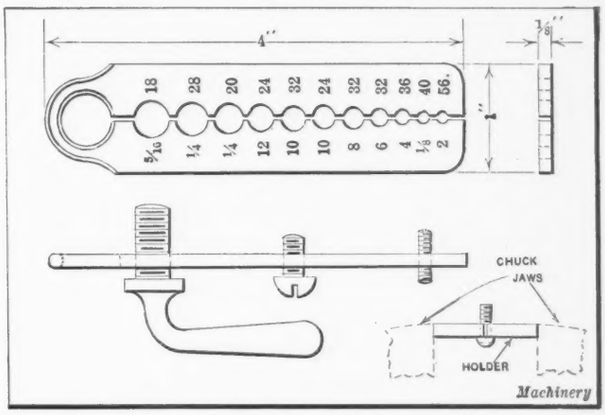
Obviously this method is also an advantage (in so far as the reading of the micrometer graduations is concerned) when the tool is required to be set over for cuts of greater depth. For instance, the tool would be set over for a cut of 0.0075 inch by advancing the compound rest 0.015 inch. The angular setting of the compound rest must, of course, be exact in order to obtain accurate results. If set for cuts of a greater depth than 0.010 inch the tool must be fed across the work twice, that is, in and then out. This is also the most dependable method for fine cuts

* * *

HOLDER FOR SMALL SCREWS

By ALBERT M. SARGENT

The writer read with interest the description of a device for holding small screws, which appeared on page 575 of March MACHINERY. A somewhat different type of holder which has some advantages that are not found in the one



Holder for Small Screws

referred to is shown in the accompanying illustration. This holder can be used for screws of any length and type without danger of distorting the threads. It is made from a strip of cold-rolled stock 4 inches long, 1 inch wide, and 1/8 inch thick. The strip stock was first drilled and tapped as indicated by the notations opposite the tapped holes, and was then split down the center with a 1/32-inch milling cutter. A hacksaw could, of course, be used instead of a milling cutter. It is quite an advantage to have the sizes of the tapped holes marked on the holder, but this is not necessary.

Cyanide was used in hardening the holder so that it would be slightly springy at the bow end and have a hard outer surface. In using the holder, the screw is simply screwed into the proper size hole, in the position desired, after which the holder is clamped in the vise, as indicated in the lower right-hand corner of the illustration. Small-sized screws may be released by springing the split ends apart by hand.

* * *

MEETING OF AUTOMOBILE PRODUCTION MEN

A meeting of the Society of Automotive Engineers will be held in Detroit October 26-27 for the purpose of discussing problems of automobile production, the meeting being known as the Automotive Production Meeting. Papers dealing with current production problems in a simple and practical way will be read and fully discussed in the morning meetings on both days. The afternoons will be devoted to factory inspection trips where new and advanced production methods that will particularly interest the tool, inspection, and production men, will be shown. The principal object of this meeting is to promote an interchange of ideas between practical factory men. K. L. Herrmann, production engineer of the Studebaker Co., Detroit, is chairman of the committee.

Rivet Spinning Operations

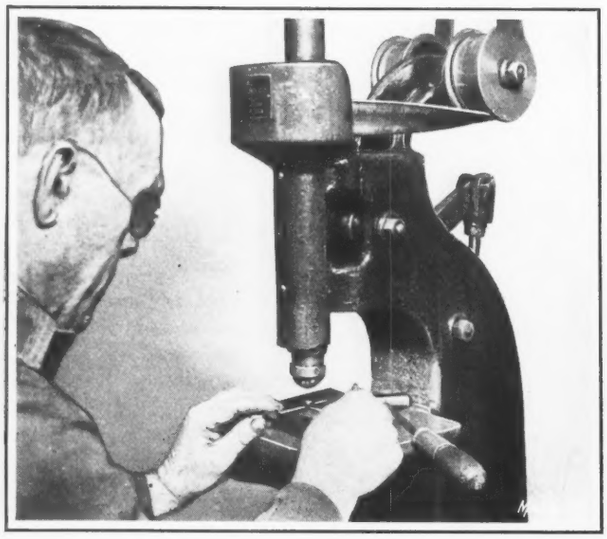


Fig. 1. Spinning the Eccentric Stud by Means of which the Locking Levers are assembled

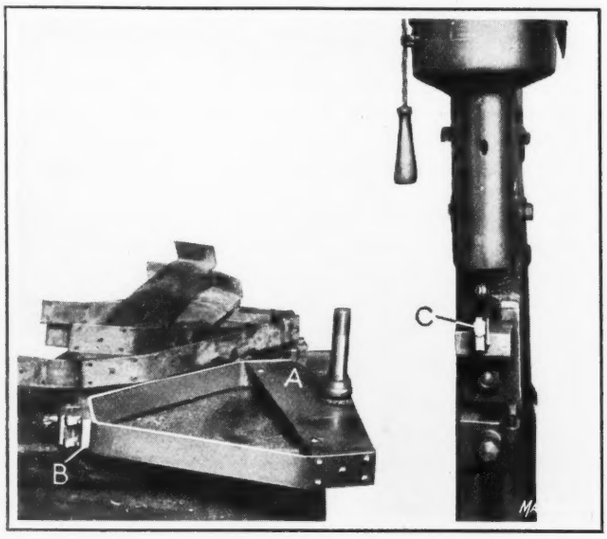


Fig. 2. Riveting Machine set up for spinning Rivets in Wire Reel Cart Frames

RIVET spinning—in the general meaning of the term—includes spinning heads on pins, studs and bushings, as well as rivets. In "setting-down" a rivet, or pin-head by spinning, the action on the metal differs from that which occurs when the work is performed by hammering, inasmuch as when spinning, the metal is pressed with a rotary movement into the shape desired instead of being pounded. Both methods have advantages according to the results desired. A spun rivet is not distorted on the body and does become tight in the hole as a result of the spinning action. This is likely to occur when a rivet is hammered, and for that reason a trip-hammer is often purposely employed to bring about this condition. Where a free-acting joint is required, however, spinning produces the best results, and the applied pressure of the rolls can be so controlled as to obviate bulging or distorting the rivet body. The rolls by which rivets are spun require more working space than a rivet hammer, and hence, a hammer is necessary in cases where lack of room prevents the use of spinning rolls. Obviously, a hammer cannot be used for heading bushings or for flaring pipe, for the performance of both of which operations a spinning machine is well adapted.

Riveting machines that spin rivets, pins, and other fastenings by a pair of rapidly revolving rolls, such as those built by the Grant Mfg. & Machine Co. of Bridgeport, Conn., are provided with rolls carried in a holder in which they are free to revolve while they are pressed against the rivet or pin as the machine spindle rotates at high velocity. A tongue in the holder separates the rolls which are set at a slight angle. The tongue serves to clear the burrs that work up between the rolls during the spinning operation. The revolving rolls cause the metal to spread and assume the proper form of head. The rolls may be made with flat, concave or angular faces to suit the shape of head desired; also special shapes may be employed. The machines are built in either the vertical or horizontal style, in both of which styles the arrangement of rolls and their action is the same. One feature of these machines is the absence of noise which is characteristic of hammer-riveting.

Rivet heads which are spun have a well-finished surface, the metal being spun smoothly and firmly into shape by the action of the rolls. These may be made with flat ends to produce round domes; round ends, cone points, and countersunk ends to produce either oval or flat heads; and chamfered bushings to produce a flat surface that is flush with the work. If the rivet or other fastening is a free sliding fit in the hole, the anvil supporting a round-head rivet is made with a slightly deeper cup, and to a smaller radius than the curvature of the rivet-head, which prevents it from turning. In the case of a flat-head rivet or pin, the anvil is often serrated for the same purpose. The average working speed of these machines is 1750 spindle revolutions per minute. A few examples of the work for which the rivet spinning machine is adaptable, are given in the following.

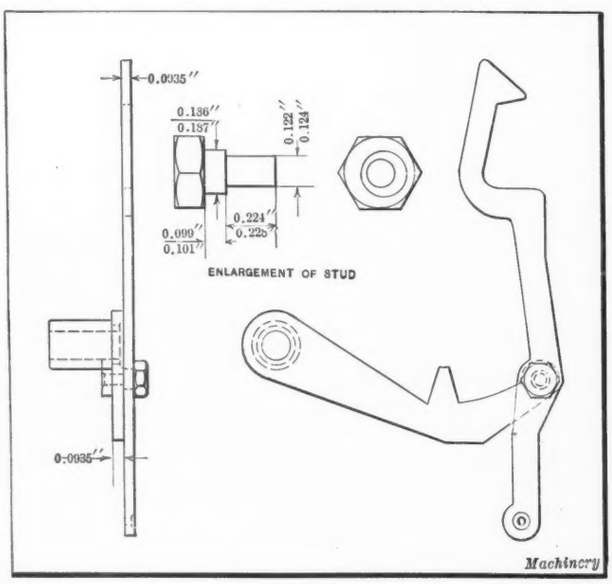


Fig. 3. Locking Unit of a Calculating Machine assembled by riveting

Spinning Steel Stud in Calculating Machine Part

The carriage lock for a Monroe calculating machine, and an enlarged view of the stud used in its assembly, are illustrated in Fig. 3. The shoulder of this stud is eccentric relative to the body diameter and head, the purpose being to provide means for adjustment between the hook-end of one lever and the cam-

lug of the other. This adjustment is accomplished by simply turning the stud and heavy countersunk washer to which it is riveted. The thickness of the two lever members of the lock and the washer is such that 3/64 inch of metal protrudes to be spun flush in the countersunk hole in the washer.

The operation is illustrated in Fig. 1 where it will be seen that a block is used on the regular table of the machine to accommodate the two levers to be assembled. The operator holds the work in position, moving the hook-lever back and forth to determine the freedom of action while the rolls are spinning down the rivet.

The operator then fits the stud into the two parts, assembles the washer, places the parts in position on the block and operates the foot-treadle to apply pressure to the stud. After spinning, the operator frequently uses a brass hammer to free the joint. The end of the stud is lubricated with vaseline. On account of the amount of care and inspection that each unit receives, the production is not high. The output is 184 locks per hour.

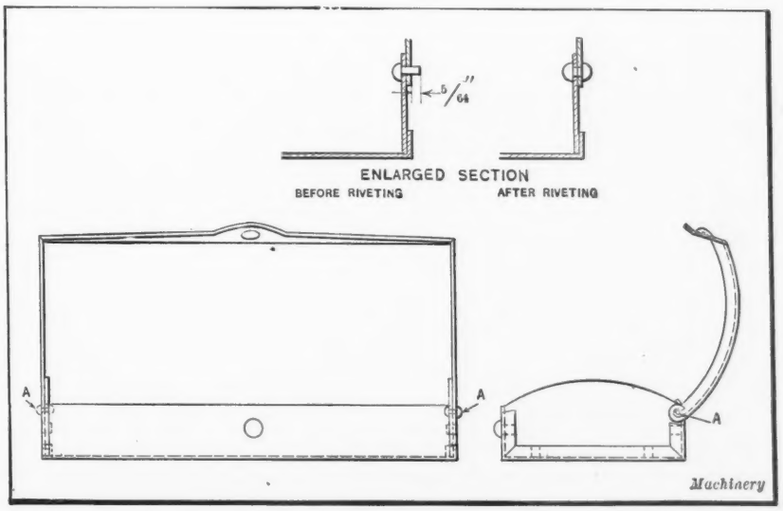


Fig. 4. Safety Razor Case in which Two Rivets are spun to produce the Cover Hinge

Riveting Frames Made of Flat Stock

The Dilwood Mfg. Co. of Newark, N. J., manufactures a wire-reel cart for the U. S. Army, which is used for field work by the Signal Corps. This cart is collapsible and is a good example of "fabricated" work, in the manufacture of which arc-welding and rivet spinning are extensively used.

The two end frames of the cart, one of which is shown in Fig. 2, are locked to a rectangular side frame by clamp levers which engage steel buttons, riveted into the gusset plate *A* of the end frames and thus may be disassembled at will. The side frame is made of flat stock which is first bent to shape and tacked at the joint by welding and then riveted. The frames are reinforced with cross-braces which are held in cast-iron bearings, riveted to the sides of the frame. In all, there are twenty-eight rivets in the main or side frame, all of which are spun. This frame weighs 22 pounds; it is stated that ten frames can be fabricated with the aid of the rivet spinning machine in the time that formerly but one could be made by hand-riveting.

The end frames contain five rivets at each end for the gusset plate and four for the assembly of the cast-iron box *B* in which the shaft that carries the coil of wire has its bearing. The two locking buttons that are riveted in the gusset plates are made of cold-rolled steel, 3/8 inch in diameter, and are spun with an oval head. The anvil in which the head of these buttons rests during the riveting operation, is cupped out to contact only on the sides of the button head so that it will not revolve during the operation. For the five countersunk-head rivets a special serrated anvil *C* is used, to prevent the rivets from turning. The rivets are assembled from the inside outward, the anvil allowing the frame to hang over it when riveting from the outside. These rivets are 3/16 inch in diameter, 5/8 inch long, and are made of cold-rolled steel. During the spinning the rivets are lubricated with graphite. The sixteen rivets and two buttons are spun at the rate of one hundred frames per nine hours, in spite of the fact that the frames each weigh eight pounds and cannot be handled rapidly.

Spinning Hinge Rivets in Safety Razor Cases

An example of brass rivet spinning using a two-spindle horizontal type of machine is found in the plant of the Auto Strop Safety Razor Co., New York City. The cases, which are made from 0.022-inch sheet metal, are illustrated in Fig. 4, the two rivets being indicated at *A*. A free joint is required for the cover of the case, and the rivet holes must align; otherwise, the hinge will bind. The rivets are 0.048 inch in diameter, 0.120 inch long, with round heads, and they are loosely assembled as a separate operation to the spinning.

As the enlarged sectional views show, the rivet is spun with an oval head, for which 5/64 inch of its length is used. A special fixture is used on the machine, the set-up of which is illustrated in Fig. 5. This fixture is merely a substantial cast-iron block with a steel face, over which the case tightly fits, affording support within the case for the rivet heads to hold them firmly against the spinning action of the rolls. Two ejector pins operate through the fixture by means of the hand-lever *A*.

The design of this machine is a radical departure from the vertical type illustrated in connection with the other applications described. The opposed spindleheads are separately driven, and the spindles are advanced in

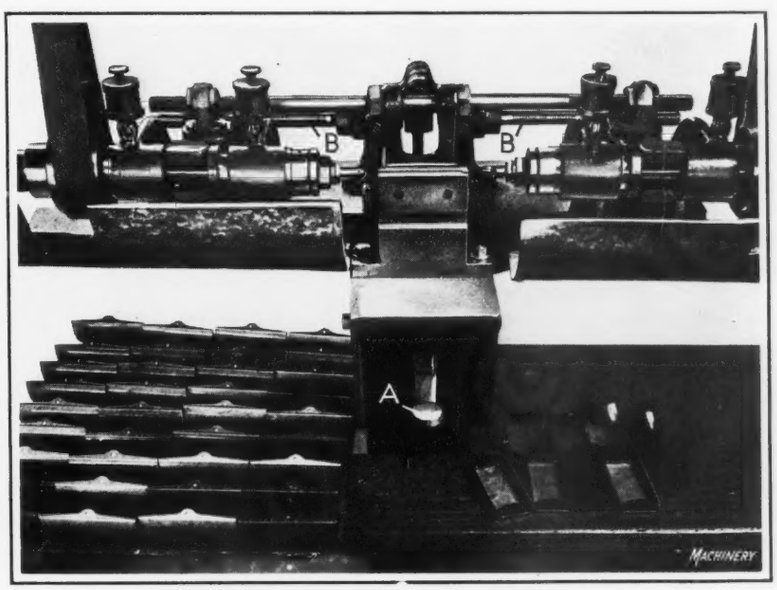


Fig. 5. Two-spindle Horizontal Machine and Fixture for riveting Safety Razor Cases

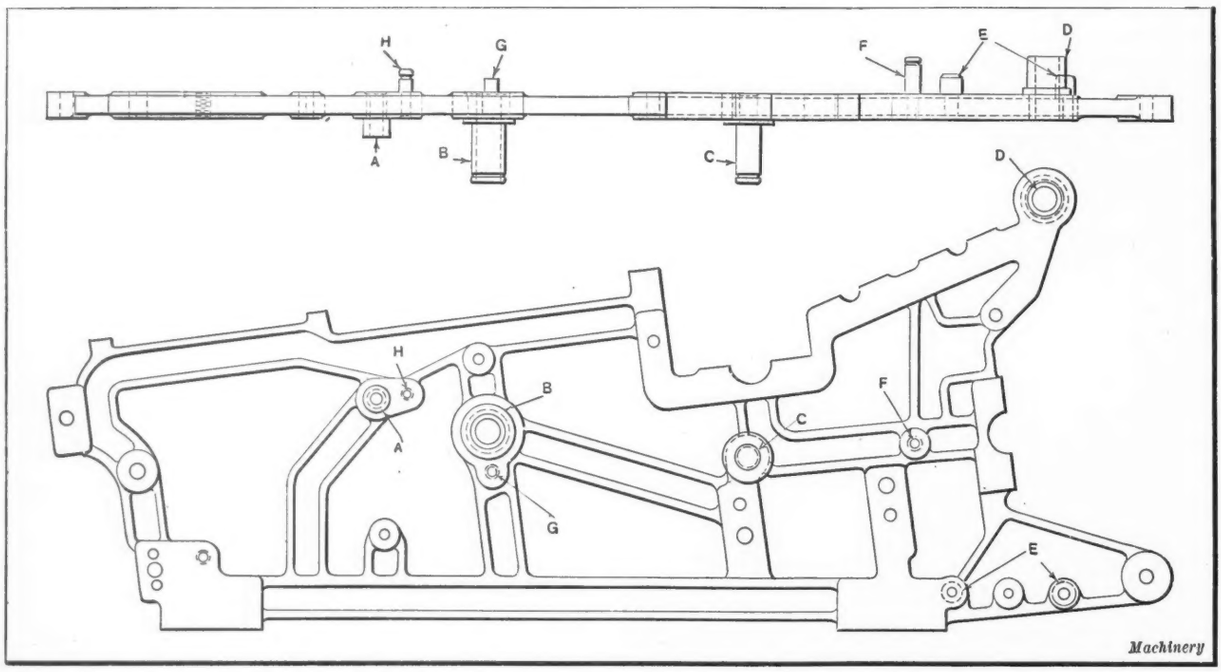


Fig. 6. Side Frame of a Calculating Machine in which Various Riveting Operations are performed

unison by a toggle-lever connection, operated by a foot-lever beneath the bench. The amount of traverse of these spindles determines the freedom of the hinged joint, and this traverse is regulated by adjusting nuts on the threaded rods *B*. Similar adjustment is also provided for setting the position of the heads on the flat side on which they operate, to accommodate work of varying length. Two-spindle riveting machines of this kind also find extensive application in cutlery plants where they are employed for the purpose of spinning the rivets by which the handles of knives and forks are assembled.

No lubricant is used in this operation but the rolls are frequently washed with kerosene. The production for a ten-hour day is 5150 cases, or more than 10,000 spun rivets.

Spinning Steel Studs and Bushings in Cast-iron Calculating Machine Frames

The two side-frames between which the mechanism of the Monroe calculating machine is assembled are made of cast-iron and contain a number of bushings and studs. The design of the frame is shown in Fig. 6, which shows the location of the various studs and bushings that are assembled into it. The riveting work is divided into three operations, the first of which is the spinning of the carriage hinge-rod bushing *D*, which is a casehardened machine steel part. This bushing is placed over a stud in a fixture block to locate it, and the casting which is countersunk to receive the head to be spun is slipped over the end of the bushing.

The bushing is also countersunk a sufficient amount so

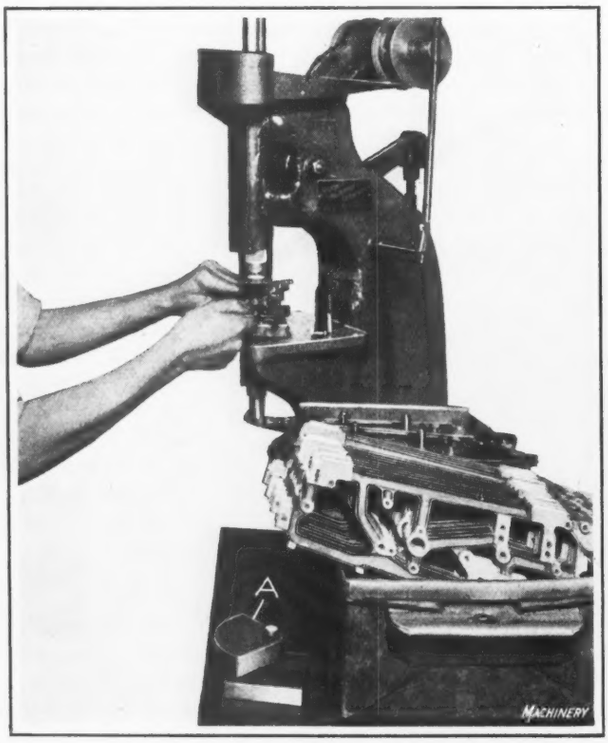


Fig. 7. Using Swivel Block for spinning Rivets of Different Diameters without rehandling the Work

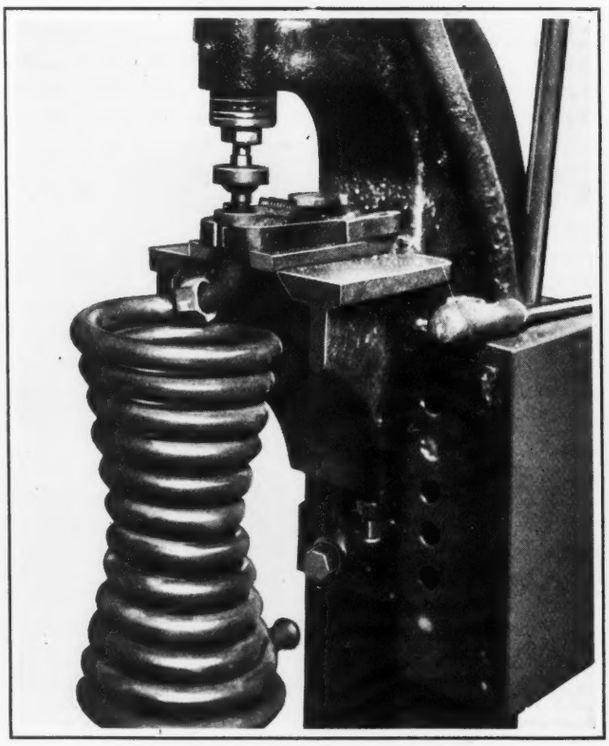


Fig. 8. Application of a Riveting Machine in which a Special Clamping Device and Special Spinning Tool are used

that as the end is spun the metal spreads into the countersunk hole in the casting, and also into the countersunk hole of the bushing. The depth of countersinks is such that the spun metal produces a flat even surface, with no metal projecting into the hole. With this arrangement the operation is completed with the spinning, and no subsequent machine work is required to clean out burrs in the hole. With a hardened steel bushing it would be impossible to ream and difficult otherwise to remove burrs; hence the importance of countersinking. The production is 230 bushings per hour.

The next riveting operation is that of spinning the keyboard clearing lever-stud bushing *A*, the crank-handle stud bushing *B*, and the intermediate driving gear stud *C*, all of which are spun in one operation. These bushings and all the other studs shown are made of cold-rolled steel. The operation of spinning the three parts just mentioned is illustrated in Fig. 7, in which also a number of pieces of work are shown. A swivel block, similar in design to that shown at *A*, and containing three locating bushings to accommodate the diameters of the work to be spun, is used. First, the casting with one bushing hand-pressed in place is located by the proper bushing in the swivel block, which is swung into alignment with the spindle of the machine where it is held by a spring pin. The second bushed hole is then used for the next bushing and so on, thus reducing the amount of handling that would be required if an entirely separate operation were used for each member to be spun.

In this case also, the bushings are countersunk and the stud has a cup point. This permits the projecting stud or bushing to be spun evenly and flush with the finished side of the casting. In the case of the bushings, which in this case are not hardened, it is sometimes necessary to ream out the holes to remove burrs formed by the spinning rolls, although the countersinking of the bushing is designed to obviate this. The bushings and the stud are an easy push fit in the casting, and are assembled by the operator of the riveting machine. The production time is sixty-four frames per hour or 192 riveting operations, which includes pressing the bushings and stud into place, and assembling the washer beneath stud *C*.

The other studs shown at *E*, *F*, *G* and *H*, Fig. 6, are a drive fit and are riveted in from the opposite side of the casting, using the swivel block already referred to. In this case, however, the work is done on a hammer machine.

Bell-mouthing Pipe by Spinning

In the plant of the Lawson Machine Co., Wilkinsburg, Pa., the end of the copper coil used in the construction of a gas heater is flared by means of a riveting machine which carries a special spinning roll-head. The set-up for the operation is illustrated in Fig. 8. It will be seen that one end of the coil is gripped in a suitable clamp after the joint nut has been slipped over, and that it is then bell-mouthed. This coil is an important unit in the gas heater, and the flared end is produced to enable a water-tight joint to be made. The rolls in this special head are placed at a suitable angle to give the radius of the bellmouth, this spinning tool being carried in the machine spindle in place of the regular roll holder. The pipe in this coil is ¾ inch outside diameter and of No. 20 gage stock. A well-formed opening in the pipe is thus secured and the production time is fifty coils per hour. This operation was formerly done by hand which was found to be slow and inaccurate.

* * *

Chatter marks on work that has been finished by cylindrical grinding are due either to vibrations of the building, unsuitable belt joints, knocking end thrust of revolving shafts, lack of balance in revolving machine parts, incorrect speed of the wheel used, lack of proper steadyrests, or wheels which are not properly balanced.—*Grits and Grinds*

SELLING PRODUCTION SERVICE

By ERNEST F. DuBRUL, General Manager,
National Machine Tool Builders' Association, Cincinnati, Ohio

It costs more to be without good equipment than to buy it. Experienced salesmen have made many sales by demonstrating that fact. It is the only argument on which any kind of machinery can really be sold, because the value of the machine to the user depends on no other quality than the saving in cost of production to be obtained through the use of the machine. The price of the machine is of no particular consequence, its design and other selling points are in themselves of no great moment, unless a saving in production costs can be shown by its use. If the saving by the use of new or improved equipment is not in proportion to the price that has to be paid, even the cheapest machine is expensive.

The great difficulty confronting salesmen of machine tools is that thousands of buyers do not think in terms of production service obtained from the machines that they buy. Too many are judging erroneously the value of a machine tool almost entirely by a comparison of the price with other machines made in large quantities. Machine tool salesmen should emphasize the fact that they are not selling machines —they are selling production service. The purchasing agent who is not a production man generally insists upon buying machines rather than service, and he will naturally insist upon buying the cheapest machine in the market. But the experienced user of machine tools knows that each machine is peculiarly suited for a particular kind of service, and he will buy the type of machine that he knows is best suited to his needs.

There are numerous instances where the cheapest machines are the machines to buy for the service to be performed; there are other instances, however, where machines of a higher grade, which usually means a higher price, are the only machines that can be bought economically. There is a field for every line and type of machine tools made. It is the judgment of the buyer that should determine which kind of machine suits his needs best; and in making a decision he should be guided not by the price of the machine in dollars and cents, but by the service which he expects from the machine. The machine that will save him the most money in proportion to its cost is the machine that he should buy.

It is false economy for the management to allow purchasing agents to think of price rather than of relative productive capacity. Purchasing agents in large concerns, particularly, are so much in the habit of buying commodities that may be bought by the pound or gallon, and the quality of which is practically uniform and standardized, that they do not seem to discriminate between the buying of goods of this kind and machinery and tools or other equipment which is acquired not to be used up as a raw material, but because of the savings in production obtainable through their use.

* * *

QUALIFICATIONS OF A TIME-STUDY MAN

A successful time-study man must have a friendly and tactful disposition. He must be willing to show fairness to the men in the shop and must be patient, diplomatic, and show no prejudices. He should possess a calm analytical mind, so that he can divide an operation into its logical elements. He should also be able to meet in an intelligent manner any argument relative to rates that is advanced by the men; but at the same time, when in doubt, he should favor the men, because only by so doing will he be able to gain their confidence, and without their confidence he will be unable to carry out successfully, for the best interest of his firm, the work to which he has been assigned.

Principles of Metal Polishing

By BRADFORD H. DIVINE, President, Divine Bros. Co., Utica, N. Y., and President of the Metal Finishers' Equipment Association

POLISHING departments need more attention than they generally receive in manufacturing plants. To obtain the best results, the polishing equipment should be installed in a room provided with good lighting and ventilation, and should be given the same attention by the man in charge of production as are the other shop departments. Instead of this, the polishing department is frequently located in the basement or in some dark corner of the shop, where the conditions are not satisfactory for good work; and when no particular attention is given to the department by the production manager, the foreman may initiate his own policy, resulting in lack of standardization, thereby often increasing the cost and lowering the quality of the product.

There is need for standardized practice in the polishing department as well as in the machining departments; but frequently when a matter pertaining to polishing, such as the kind of wheel or abrasive to use, comes to the attention of the management, it is simply referred to the boss polisher, and his judgment prevails. Sometimes his recommendations are correct; often they are not. The boss polisher is usually a graduate from the ranks and frequently looks with suspicion on any new idea that affects his work, or on the introduction of new devices or tools that may result in a change in practice being forced upon him. At any rate, standards are not generally followed except those founded on the experience of that particular foreman. There seems to be a feeling in many organizations that polishing is a phase of manufacturing where efficiency need not be seriously regarded and where engineering has no place. In reality, there are few departments where the installation of improved methods and equipment will reflect more directly on the quality and cost of the work produced than in the polishing room.

This is the first article of a series on polishing which will cover the general principles of metal polishing, polishing wheels and abrasives, polishing methods and equipment, and the making of polishing wheels. A number of examples of polishing practice in the metal-working industry will be included. The articles will deal with the art of metal polishing in all its phases, and will call attention to details that are not always regarded as important. They will prove of especial value owing to the fact that polishing has received but little attention in the technical press in the past, and they will deal with the subject in a more complete manner than has been done hitherto.

The same care should be exercised to bring about polishing efficiency as is generally done to secure better results in other manufacturing departments such as, for example, the milling and planing departments, where improved or automatic machines are frequently coming into use and faster working equipment is being introduced. It probably is true that since the polishing department has been conducted on such a neglected basis for so long, manufacturers fail to appreciate the improvements that are possible by inaugurating a change in policy. To sum up the whole situation, the average polishing department is operated at an expense out of all proportion to other departments; polishing wheels for example, are used long after they are out of true, so their efficiency is decreased sometimes as much as 50 per cent. This would not be tolerated in a modern machine shop.

Terms Used in the Polishing Field

In general, any wheel made from whatever material—leather, canvas, or wood, for example—that has a polishing abrasive glued to its face, is a polishing wheel. In a general sense, any operation performed on a polishing wheel may be termed polishing. It embraces everything from the "flexible-grinding" operations performed on rough forgings such as axes and picks, and the removal of flash from table knives and forks, to the production of the brightest luster, such as is given to surgical instruments, high quality scissors, and other kinds of general hardware. Strictly speaking, the former class of work, which consists of grinding away metal preliminary to the luster producing process, should be known as "flexible grinding," as should all other operations in which a flexible polishing wheel removes metal preparatory to plating, painting or enameling the surface. In contradistinction to flexible grinding is the process by which the surface of

metals is refined by a number of operations until it has been reduced to a degree of smoothness that is known as a mirror finish; that is, a finish such that the light is refracted from the surface as in a mirror. But in general, in the trade, polishing is the term used to cover all this work of refining metal surfaces. Polishing, however, does not include buffing, an operation that is performed with a buffing wheel—that is, any wheel to the face of which the abrasive is loosely applied, rather than glued.

Chisels, hammers, screwdrivers, wrenches, and similar classes of work which are to be highly finished, but not plated, usually require four operations which are: roughing, dry-fining, greasing and coloring. That is, by means of four operations all the finishing work is done on polishing wheels, including the roughing which is frequently regarded as a solid grinding wheel job. Sometimes there are two steps to the greasing operation—rough and fine greasing. For some hardware, typical of which are cheaper screwdrivers and wrenches that do not demand a high finish, two operations are sufficient—roughing and dry-fining.

For knife blades and cutlery the roughing operation is performed with solid grinding wheels and the polishing is known as fine or blue glazing, but these terms are never used when referring to the polishing of hardware parts, plumbers supplies, etc. A term used in finishing German silver, white metal, and similar materials is "sand-buffing," which, in distinction to the ordinary buffing operation that is used only to produce a very high finish, actually removes considerable metal, as in rough polishing or flexible grinding. For sand-buffing, rotten-stone and pumice are loosely applied.

Although this series of articles does not deal with the buffing phase of metal finishing, something should be said regarding the art which will clearly define it and remove the possibility of its being regarded as polishing. Buffing is not so harsh an operation as polishing. The abrasives which are glued to a polishing wheel are intended to grind away roughness that the grinding wheel or other cutting tool leaves—unevennesses that are often discernible only with the aid of a microscope. Buffing, on the other hand, employs such soft cutting materials as tripoli, lime, crocus or rouge prepared in cake form with tallow and other greases as a body, this being applied to the cloth buff by hand from time to time so that the face of the buff is furnished with a coating of this composition. Some metals, like German silver and white metal, are buffed before plating. Pocket-knife blades are polished with emery and then highly finished (colored) by what is known as "crocus polishing," in which a wheel, similar to a leather-faced wood polishing wheel is used for buffing. Steel parts to be plated are usually prepared for plating by polishing, buffing being employed to give a luster to the plated surface.

The Relation of Design to Finish

The best results in polishing may often depend upon the design of the piece. In fact, the proper place to approach the polishing industry with a view to improving results is in the drafting-room, for in the designing of any new article, the manner and quality of finish can be greatly influenced by the contour of the part. It is often possible to eliminate small concave surfaces without affecting the appearance or the usefulness of the part, and by this means make it possible for a polishing wheel to reach all surfaces to produce the desired finish. The contour should, if possible, be such that it can be readily followed by the polishing wheel. Oftentimes a small expenditure in forging or in casting, by making minor changes in dies or patterns, will result in a large saving in finishing the article. It is not unusual, by some simple change in the original design, to obtain a sufficient reduction in the cost of finishing, to create a substantial advantage over a competitor.

The polishing of large surfaces is not difficult—it is the small concave surfaces, corners, and recesses that are expensive to finish, because it is almost impossible for a narrow-faced or small-diameter wheel to work effectively at the desired speed and reach such inaccessible places. The great number of these difficult surfaces found in the design of gun parts makes the finishing of this class of work comparatively expensive and the methods of performing the work of special interest. The exterior surfaces of those parts which make up the attractive appearance of firearms cannot be dispensed with without seriously affecting the market value of the product, but there are a great many articles which are finished by polishing that could easily be changed in design to facilitate the work of polishing without affecting in any way the selling value of the product. These things should receive careful consideration by the management of any manufacturing organization.

The methods of performing various operations prior to polishing also have a direct affect on the cost of finishing as well as on the quality of the finished surface. A good illustration of this phase of the industry may be noted in connection with the production of axe heads and similar forged implements. In forging, scale gathers on the surface of the hot metal and in the forging operations becomes imbedded into the surface to such an extent that in finishing, the pitted surfaces thus produced must be removed, which sometimes requires the grinding away of 1/16 inch of metal in order to reduce the axe head to a condition where it can be finished satisfactorily. To remove this unnecessary metal the practice followed in one shop was first to use a solid grinding wheel, which left a wavy surface so that it became necessary to semi-finish-grind before any polishing could be done. The result was that several operations were required to finish the axe head, whereas, with proper attention to the forging of the heads these operations could have been reduced. The method of manufacture was later changed and the work done without these extra operations. The elimination of grinding on a solid emery wheel was accomplished by simply wire-brushing the scale as it appeared on the hot forging between operations. There are many similar instances where great savings in polishing costs could be made by some such simple means as that mentioned.

Broader Application of Polishing

The advantages which may be obtained by flexible grinding with formed-face polishing wheels have resulted, during recent years, in this means being used largely for certain classes of work to supplant the use of solid grinding wheels. This is made possible by the improvement in polishing wheel design to an extent that the coarser-grain, fast-cutting artificial abrasives commonly used for flexible grinding may be effectively held on the periphery of the wheel. In this connection, of course, the holding power of glue and the resistance to frictional heat produced are of vital importance. Work produced by polishing wheels instead of solid grinding wheels is economical, because with the solid wheel the surfaces left are wavy, so that a number of operations are required to polish the surface. The forgings and castings are often taken directly to the polishing department for roughing without being first ground, and if the polishing wheel is properly designed and applied, it will leave a smooth surface for subsequent operations. This principle of employing a flexible grinding tool rather than a solid wheel results in fewer operations being required to finish a surface.

* * *

A certain type of foreman prides himself on treating all men alike, but he might just as logically take pride in the fact that he applies the same methods to the heat-treatment of all kinds of steels. Men differ in analysis far more widely than do steels.

Making Radio Parts

By FRED R. DANIELS

Molding Radio Insulator Products—Description of Dies and Methods Used

LARGE quantities of molded products are used in radio equipment. Many of these are molded with brass inserts to provide means for electric circuit connections in radio instruments. Although the main purpose of employing molded materials so extensively in radio instruments is to furnish adequate electrical insulation, numerous molded parts are also used as control knobs and handles. This article contains two examples of molded work having metal inserts, and two examples in which inserts are not used, but which are good examples of molding radio parts. The practice described is that of the Shaw Insulator Co., Newark, N. J.

The materials commonly used for this purpose are condensite, redmanol, bakelite, formica, electrose, etc.—all condensation products of phenol and formaldehyde—and shellac compositions. The first class of materials is prepared both in powdered form and in sheets of about ¼-inch thickness, but the shellac compositions are made in sheets only. The powder is used in "closed" or "positive" molds; that is, molds into which charges of powder are placed that will exactly produce the desired part without any overflow. The "open" or "negative" mold, on the other hand, is one in which sheet stock is used; here the lower die cavity is surrounded by an overflow channel into which the excess material is forced as the cavity of the die is filled under pressure. This overflow is a total loss, as it cannot be used again. On removing the parts from negative dies, they are usually surrounded by a liberal flash and in some cases, where the filling out of the piece is difficult, this flash will be heavy enough to hold an entire string of parts together.

There is also what might be called a "semi-positive" method of molding in which the molded product used is also in sheet form, but the pieces of material used are carefully weighed to agree with the weight of the finished article. This practice, however, is followed only in cases where the design of the die is such that the amount of overflow must be limited because it is impracticable to provide a large overflow channel in the die.

The principle employed in the making of molded insulator parts is that of combined heat and pressure; pressure is supplied by a hydraulic press, through a pump and accumulator, and the heat by live steam. In the practice described, Watson-Stillman hydraulic presses are used which are designed to furnish a pressure of 2000 pounds per square inch. For heating the platens of the press between which the dies are placed, a live steam pressure of 90 pounds is regularly used, which gives a temperature of 320 degrees F. The combined heat and pressure are applied for variable lengths of time, the duration depending on the size and sectional area of the part being molded. The steam is not passed through chan-

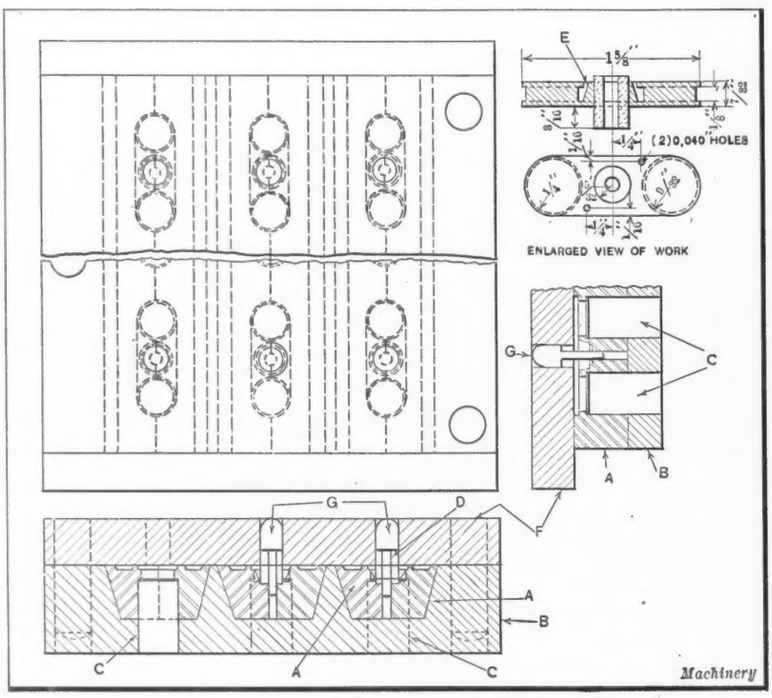


Fig. 1. Enlarged View of Condensite Bobbin and Dies in which this Bobbin is molded

nels in the dies (as is sometimes done) but is conducted to the dies by contact with the hot platens. The dies are prepared for the press on heated tables or work-benches made of iron, so that they are not cold when placed in the press, but already hotter than the bare hands can stand.

Molding Small Bobbin Having Brass Insert

The first example of molded work to be considered is that of a condensite bobbin made for the American Radio & Research Corporation. The bobbin is used as a vernier adjustment in connection with variometers; an enlarged view of the finished product is shown in the upper right-hand corner of Fig. 1. The main point of interest in connection with this job is the construction of the dies, this being a job known as a "side-draw" job, that is, on account of the flanges which surround the spool portions of the bobbin, it is necessary to draw the sections between the flanges from each side. This calls for the use of pairs of bars *A* which are set into the base plate *B* of the die at each of its three stations.

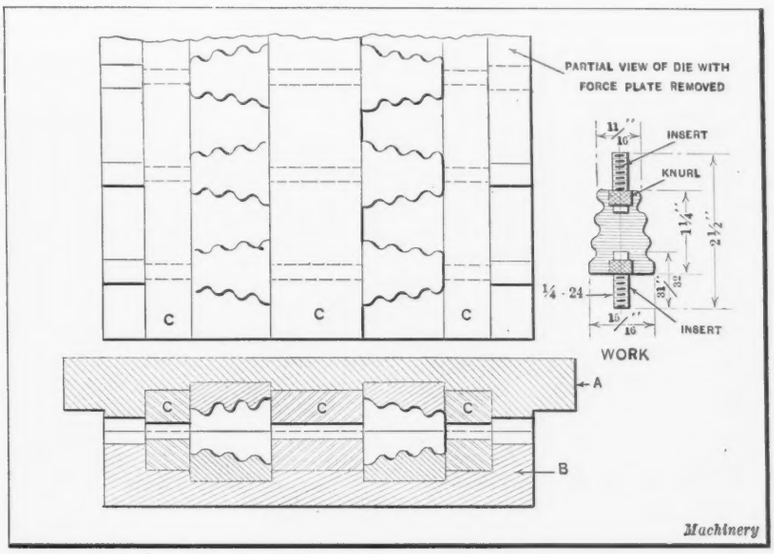


Fig. 2. Dies used in molding Insulators for Radio Variable Condensers

Each of the three pairs of bars *A* has accommodation for three bobbins and each pair encloses three pairs of plugs *C* which form the bottom surface of the spools. Between each pair of semicircular holes in these bars, there is a countersunk opening leading to a whole which passes through them. Each countersunk hole furnishes a seat for a brass insert *D* and leaves a cavity around the end of the insert so that the material may be built up around it and reinforce it, as indicated in the view of the work at *E*. The bars *A* are furnished with a shallow channel which surrounds the die openings, this being necessary in a negative mold, and is the provision for receiving the overflow material.

The top or force plate *F* carries three dowel-pins by means of which it is aligned with the base plate, and in this force plate there are holes directly over the countersunk holes in which the inserts are seated in the bars *A*. Each of these holes provides accommodations for a protector pin *G* which not only serves to prevent the molded material from entering the central hole in the insert, but also acts as a pilot to position the insert vertically and correctly. The force plate is made of hardened tool steel; the base-plate of unhardened tool steel; the bars of Ketos steel, hardened; the plugs *C* and the protector pins of drill rod.

Preparation of the Mold

After the dies are taken from the press, they are placed on the steam-heated table or work-bench where the removal of the work and the loading of the dies is done. In preparing the mold, the condensite sheets are broken into pieces of approximately correct size, which can be readily determined by the skilled operator, and these are laid on a cloth where they are warmed by the hot plate. The bars *A* are first located in the base plate and the inserts dropped into place in the countersunk holes. The protector pins are then put in place and the cavities jammed full of the now plastic pieces of sheet stock to the extent that they are built up around the protector pins *G*. The operator can usually time his work so that the sheet stock is not allowed to become heated beyond a certain degree. If too much heat is applied to the material it becomes ruined and cannot be reclaimed. The operator, of course, works with heavy leather gloves because the dies are always too hot to be handled with the bare hands.

There are two small holes 0.040 inch in diameter in the work, these being blind holes for the lead wires from the bobbin winding. For the sake of clarity, the two small pins or cores which produce these holes were not shown in the sectional views of the assembled dies, but they are carried in the force plate. As soon as all the inserts have been set in place and the die cavities built up with plastic material, the mold is closed by slipping the force plate over the aligning dowel-pins. The prepared mold is then placed in the press where it is subjected to the required 2000 pounds per square inch pressure for a period of about three minutes.

The hot die is then removed from the steam-heated hydraulic press and placed between the pressure plates of another press in which cold water is used in place of steam. This sufficiently lowers the temperature of the dies so that the hot plastic material, still under pressure, will become completely solidified and shrunk sufficiently to permit ready removal upon opening the dies. The hot dies are left in the cold press for a few minutes, the length of time depending

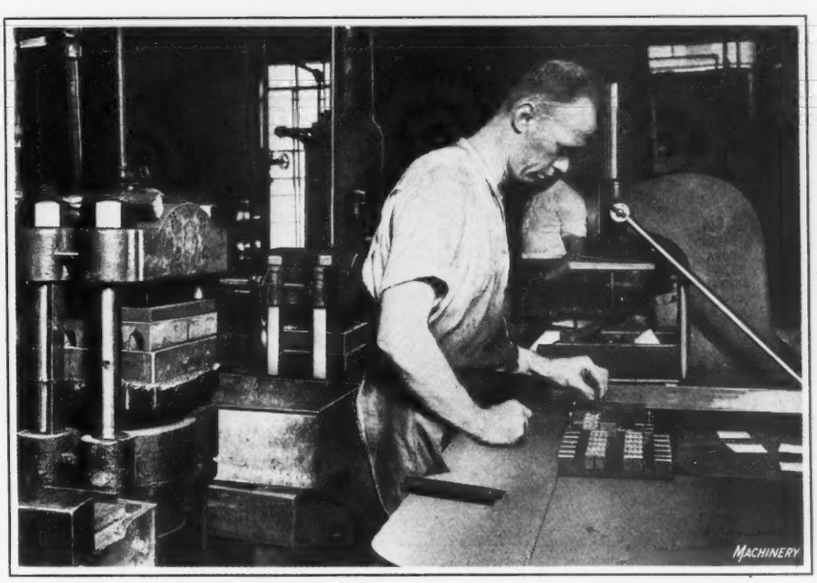


Fig. 3. Preparing the Mold for producing Variable Condenser Insulators

on the judgment of the operator and being regulated in accordance with the size of the work. When the dies are opened they are reversed in position; that is, the force plate is at the bottom, so that the bars *A* are on the force plate instead of in the base plate channels in which they are contained when the die is prepared for molding. This arrangement makes it possible to draw the bars from the side.

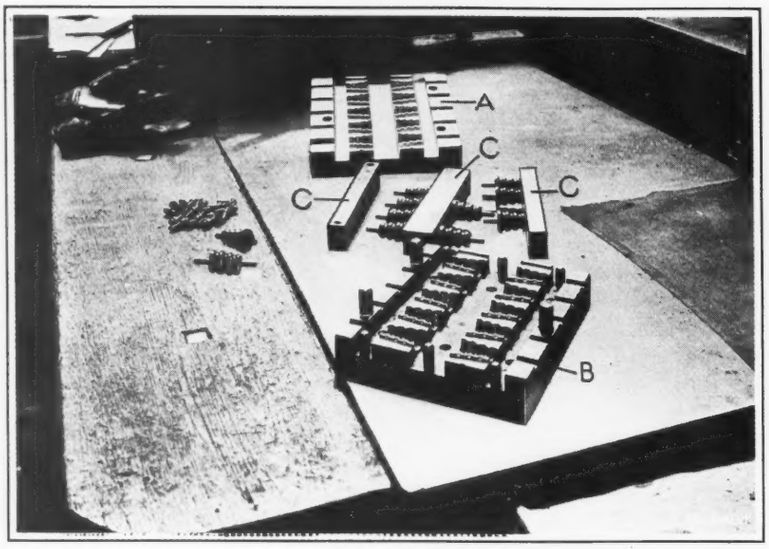


Fig. 4. Parts of the Dies shown in Fig. 2

The next example of molding work is that of a variable condenser insulator, this part being made of sheet redmanol in what might be termed semi-positive dies. A sectional view of this insulator, which is made for the Wireless Specialty Apparatus Co., Boston, Mass., is shown in Fig. 2, also a sectional view of the dies and a partial plan view with the force pate *A* removed.

The baseplate *B* contains three channels in which bars *C* are located by dowel-pins. There are holes spaced in these bars for the accommodation of the inserts which are molded into the insulators. Referring to the view of the work, it will be seen that there are two of these inserts. They are made of brass, have a coarse knurled head and are threaded. The shoulder of the knurled head serves to locate the inserts in the bars and they are slipped into the holes before the bars are put into the die. As soon as the operator has set the inserts into the three bars, pieces of sheet redmanol which previously were weighed to obtain a close approximation of the mass required, and which have been warmed to a plastic state during the preparation of the die, are broken into small pieces which are tucked under the knurled heads of the inserts that project into the cavities in the base plate.

Fig. 3 shows the preparation of this die, after one row of cavities has been filled. The remaining space between the bars is piled high with the plastic material and then the die is closed by means of the force plate in which there are channels to receive the upper part of the insert-carrying bars *C* Fig. 2. This illustration Fig. 3 shows a number of the pieces of redmanol on a cloth, being warmed on the heated plate or work-bench and gives an idea of the size required for the production of this particular insulator. The pieces of sheet stock are about 2½ inches square. The press shown in the foreground is the hot-press and the other is the one in which the dies are cooled by circulating water upon removal from the steam-heated press. The difficulty of providing overflow channels in the dies for this part accounts for the fact that although sheet stock is used, it must be nearly a positive mold. The only escapement for the material that is possible is at the parting, and this

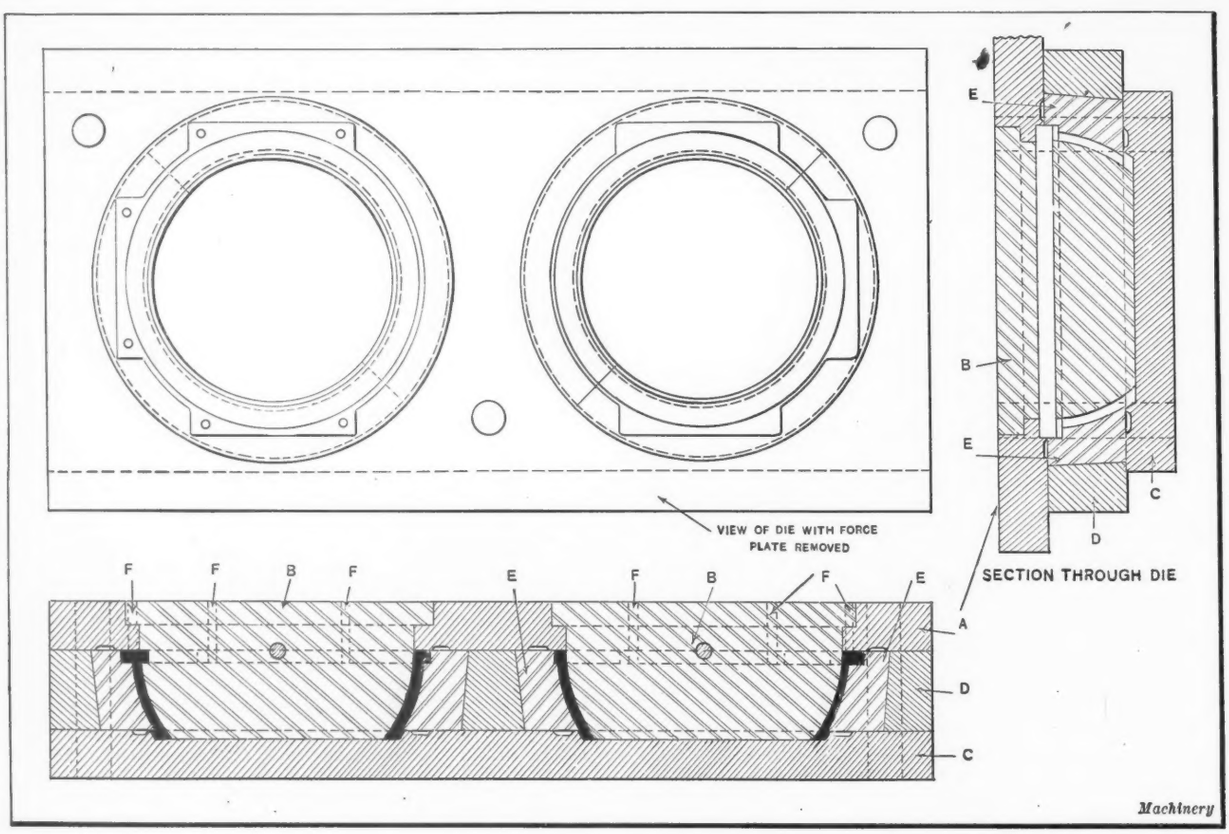


Fig. 5. Dies from which Two Halves of a Variometer Stator are produced

must be kept to such a small amount that the dies will not be prevented from practically coming together. About five minutes is required to mold a set of ten insulators in these dies.

The dies, after they have been opened and the work partly removed, are shown in Fig. 4. The base plate *B* is in the foreground and the three bars *C* are shown with the finished work as it appears when the dies are opened. The force plate *A* is shown in the background. It is necessary to scrape off all particles of plastic material which may have stuck to the matching surfaces of the die-plates, and if this is not done the dies will not be properly closed and will result in an unsatisfactory product. The die-plates, insert bars and pins are made of the same materials as corresponding parts of the dies shown in Fig. 1.

Molding Stators for Variometers

The stator of the variometer used in the Adams-Morgan regenerative circuit receiving set consists of a hollow spherical member which is molded in halves, each part carrying three flanges by means of which the two halves are joined. The rotor member of the variometer revolves within the stator and it has a shaft extending through the stator to which connection to the secondary winding is made. The bearings for this shaft are formed by two semicircular grooves molded into each half of the stator, passing diametrally through two of the flanges mentioned. One of these stator members is shown lying on the die-plate in Fig. 6 and its sectional shape is indicated in Fig. 5, where the work is shown in the dies by solid black sectioning. The stators are made from Shawlac (a shellac composition) which is considerably less expensive than the condensation products, and, for certain uses, just as suitable. This material, in sheet form, is handled in molding much the same as other molding jobs wherein sheet stock is used.

The construction of the dies is plainly indicated in Fig. 5 where sectional views are shown and a plan view with the force plate removed. The force plate *A* carries two force plugs *B*, through each of which there extends a steel pin, the center line of which coincides with the parting line of the stator halves. These pins extend on both sides of plugs *B* and are the means of forming the half bearings for the rotor shaft in the flanges. The base plate *C* carries an intermediate plate *D* known as a "chase." The chase is machined to receive two split rings *E* for each mold, the rings being located in proper position by pins carried in the base plate. The necessity for this construction will be apparent when the sectional shape of the stator is observed. It would be impossible to remove the work from the dies, on account of the rib at the small end, if the construction did not permit a side draw.

Overflow channels for the excess stock are provided in the force plate and in the base plate, which are shown located close enough to the mold cavity to permit the plastic material to ooze into them when under pressure. Two holes are molded in each of the three flanges for the purpose of assembling the two members together and these holes are formed by pins *F* carried in the force plate. The force plate is made of unhardened tool steel; the base plate, chase, plugs and split rings from pack-hardened machine steel, and the pins and dowels from drill rod. The view shown in Fig. 6 should be self-explanatory after what has already been said regarding the preparation of molds for the production of other articles. The operator is in the act of cutting the sheet stock to fill in around the split die rings, these having been removed for one of the two impressions; they are lying on the heated work-plate just back of the dies.

Fig. 6. Preparing the Mold for the Variometer Stator

Fig. 7. Weighing out the Molding Material

Bases for Filament Rheostats

All the examples of molded work described up to this time have been made of sheet stock, and have been produced in negative molds. When an article is produced by the positive method, the raw material is used in the form of powder and is carefully weighed so that each charge will contain no excess material. The DeForest filament rheostat is made in this way: It is molded from No. 160 condensite powder and the operation of preparing the mold for this job is illustrated in Fig. 7. Views of the work are shown in the lower right-hand corner of Fig. 8 in which illustration sectional views and a plan view of the dies are also presented. The general die arrangement is not radically different from that already described, except, of course, that there is no overflow channel. When the work is removed from the die impressions of a positive mold, there will be no perceptible fin or burr produced, if the charge has been weighed out accurately.

The force plate *A* carries the force plugs *B* which extend into the chase *C* as shown, when the die is assembled. Similarly, other plugs in the base plate *D* extend up sufficiently to produce the proper die cavities within the chase. The

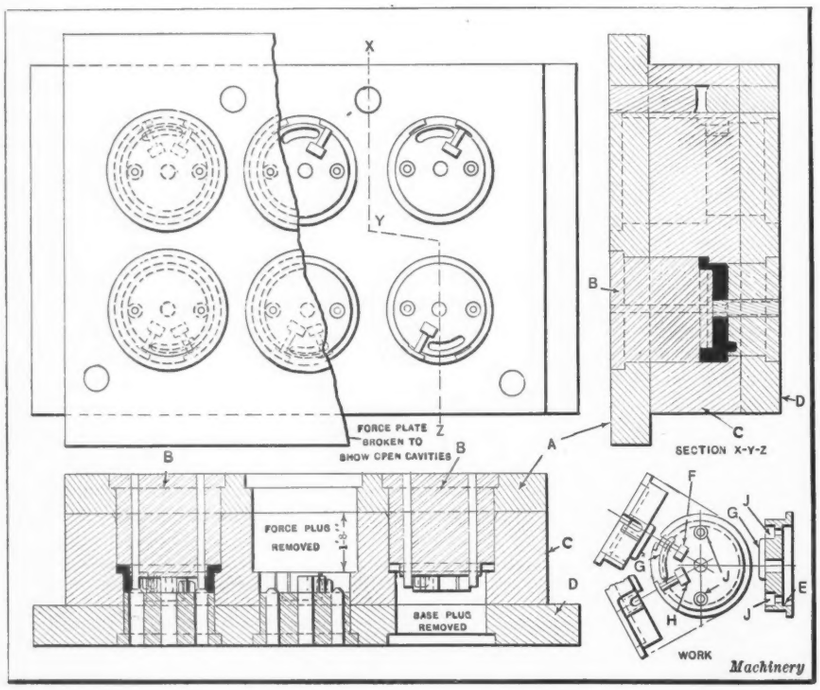


Fig. 8. Rheostat Base and Dies by which it is produced

plugs in the force plate form the countersunk hole *E* and the two small holes leading from it which are countersunk on the opposite side of the work; also these plugs carry a T-shaped member for forming slot *F*. The faces of the plugs in the base plate contain cavities in which the arc-shaped lug *G* is formed; also a T-shaped projection for slot *H* and pins for forming the countersinks *J*.

The longitudinal sectional view shows the dies with one plug removed from both the base and force plates and with both plugs in place in the third station, where a section of the work is shown in heavy lines. The amount of displacement of the charge of powdered condensite is reduced by the 2000 pounds per square inch hydraulic pressure exerted, to approximately one-third its original volume. In designing a positive mold it is, of course, essential to know the exact amount that the material is compressed so that the depth of the chase can be determined accurately; otherwise the work will be molded too thick or too thin, as the case may be. The materials that are used in making the various die parts are the same as those used in similar die parts already described.

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MOLDING THREE-PART WORK IN A TWO-PART FLASK

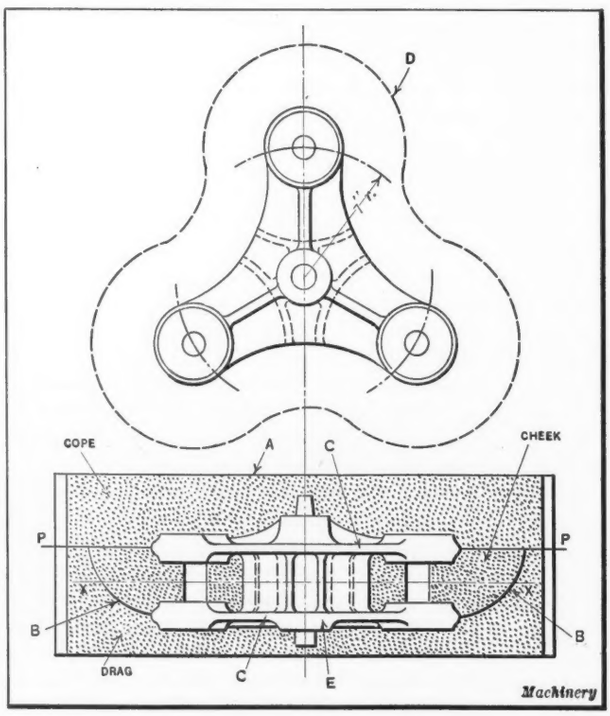
By M. E. DUGGAN

A method of molding three-part work in a two-part flask is here illustrated. The pattern is that of a spool reel frame having the parting line at *XX*. It was originally designed to be molded in green sand in a three-part flask instead of in a two-part flask as described in the following. The writer has found that this method of molding is not often brought to the attention of those outside the foundry, and for that reason believes that the following description will be of general interest.

The procedure in making the mold is as follows: First a bottom board of wood is laid down on the floor of the foundry. The cope flask is then laid on top of this board with the edge or side *A* in contact with the board, the side coinciding with the parting line *PP* being uppermost. Molding sand is next shoveled in up to the top of the flask. After being rammed and the surplus sand struck off, either by hand or by the use of a trowel, the sand is dug out of the center of the mold so as to permit burying the pattern up to the parting line *PP*. Then the space left around the pattern is again filled in and the sand struck off level with the top of the flask or parting line. The molding procedure described in the foregoing is what is known in foundry parlance as "green sand match."

The "cheek" shown within the curved lines *B* is made as follows: The space within the side frames *C* is filled in with molding sand to the outer edge of the pattern; the molding of the cheek is then continued so that this part of the mold is shaped or formed within the section indicated by the dotted line *D*. Iron rods are laid crosswise in the cheek to aid in securing and supporting this section of the mold. The filling in with sand, tamping, banking, and shaping of the curved part of the cheek is all done by hand. The shape or outline of the cheek is not required to be exact, although some patternmakers employ a sweep to finish the work.

The drag flask is next placed in position on the cope and molding sand filled in and rammed up in the usual manner. The drag flask is then lifted off and the top half *E* of the pattern drawn. If necessary, the mold is mended, after which the drag is returned to its position on the cope flask. A bottom board is then laid on top of the mold and the whole assembly clamped securely with iron clamps and wedges. The mold is next rolled over and the cope lifted off. The sand is then shaken out of the cope, after which the cope is put back on the drag. When the cope is in place, the pouring sprue sticks are set in position in the mold and sand shoveled in and rammed up. After venting the mold and withdrawing the sprue sticks, the finished cope is lifted and the upper half of the pattern drawn out. Cores are then set in place and the mold finished in the regular way and made ready for pouring.



Spool Reel Frame molded in Two-part Flask

The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, August 14

WITH the settlement of the recent labor disputes it was hoped that industry would gather momentum. So far direct evidence of improvement is wanting and fresh trouble has arisen over the reduction of wages in the engineering trades. The proposal of the employers has been rejected by ballot of the unions concerned, about 60 per cent of those voting being against a settlement on the terms offered. As, however, only about 15 per cent of those entitled to vote recorded their opinion, this attitude is not looked upon as serious, and the advice of the leaders to accept the conditions in spite of the adverse ballot is not surprising.

Whatever the merits of the frequent statements of high costs of production, it is anything but satisfactory to witness the falling of wages in the skilled engineering trades to figures lower than still obtain in a large number of unskilled occupations. There have been many misgivings on this point, as it is felt that the ultimate result will be a secession from skilled trades of the better type of men and a consequent lowering of the calibre of the engineering trades as a whole. The serious condition of unemployment during the past months has been a weighty argument in favor of the unions accepting the terms, and no doubt the majority of the men abstained from voting in the recent ballot because the alternatives appeared to be lower wages or unemployment.

The next question to be considered in the negotiations is the question of payments by results. The opinion is expressed that many leading firms will shortly be adopting payment by results in one form or another. The hostility on the part of the men toward piece-rate systems may be influenced by a convincing guarantee on the part of the employers that present time rates once fixed shall not be altered unless a change in materials or method of production warrants it.

The machine tool industry shows little definite improvement. Makers, generally speaking, are working full time, but with a considerably reduced number of employes. Important machine tool firms in the Midlands report some big inquiries for tools for the automobile industry, and they expect to be busy by the autumn.

It is confidently anticipated that the railways will be in the market again very shortly, and in the Manchester district orders have been booked for heavy and medium-sized machines suited to the requirements of the electrical industry.

Reductions of 20 to 25 per cent below current list prices of standard lines have stimulated some business, and some orders have been influenced by the consideration of the reduction in manufacturing costs that the installation of new machines is likely to effect, rather than by the question of actual first cost.

Overseas Trade in Machine Tools

The official returns for the overseas trade in machine tools for June show that the drop that took place in May has been continued almost uniformly during June both in tonnage and total value. The tonnage for June was, exports 560, imports 186. The value of the exports was £78,445, that of the imports being £25,562. The values per ton rose in both cases, the exports reaching £140 per ton and imports £137 per ton. The curves for exports show a drop during the last twelve months from 1600 tons to 600 tons, the value falling in a corresponding period from £250,000 to £78,000. For the first half of this year exports are only about half of those of the same period last year, and what is more serious, the tonnage is only 83 per cent of the pre-war average.

The exported machine tools still include a preponderance of lathes, of which 216 were exported in June. Apart from machine tools not coming under the usual standard classifications, drilling machines were the next most important export—109 being exported during June. Most classes of machine tools were imported in about equal quantities.

General Engineering

In the automobile industry, there is a good demand for light passenger cars, sufficient to keep the makers moving, but industrial vehicles sell slowly and no improvement is expected until trade is more firmly established. Crane makers are doing fairly well and have secured some good foreign contracts. Structural engineers report nothing to justify undue optimism, but confirm the general belief that business has now taken a definite turn.

In the locomotive industry, the long-expected continental and Indian orders have not yet matured, and buyers seem still to be waiting for lower quotations. The Imperial Government Railways of Japan have ordered thirty-four complete electric locomotives from the English Electric Co., Ltd. Eight of the locomotives are for heavy express passenger service, and weigh approximately 96 tons each. They are designed for hauling a 415-ton train at a speed of about 60 miles per hour. Most of the work in connection with the locomotives will be carried out at the works of Dick Kerr, Ltd., Preston. The English Electric Co., Preston, has undertaken the electrification of 2500 kilometers of the French Midi Railway. The same firm is also carrying out the electrification of the Arthur's Pass section of the New Zealand Midland Railway.

A maker of laundry machinery announces more orders in July than in any month this year, and a general opening up of business suspended during the last two years. In shipbuilding circles the conditions are still very depressing, and new work is not forthcoming despite the lower production costs in effect.

Developments in the Engineering Field

The last two or three years have seen an important increase in the attention given to malleable iron castings in this country. There had been a tendency to look upon malleable iron castings with suspicion, due in the past no doubt to a tendency of manufacturers to adhere to old-fashioned and rule-of-thumb methods. The result has been that nothing like the development of these valuable products have been made here that has been made in America. The recent conference of the Institute of British Foundrymen of Birmingham served to focus attention on the development and improvements that have been effected, and considerable attention was paid to the paper read by Professor Touceda on the practice of American foundrymen. It is expected that the near future will see a great increase in the use of malleable castings.

The National Physical Laboratory, which has already carried out useful work in the development of inspection methods, has been turning its attention to the production of plane surfaces accurate to within 0.00001 inch. It has also applied new processes to the production of snap gages and the preparation of the faces of end measuring rods which will be maintained as standards in the Laboratory.

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FRANKLIN D. JONES, ASSOCIATE EDITOR
EDWARD K. HAMMOND, WESTERN EDITOR

STANDARDIZING MACHINE TOOL NAMES

Reference has been made previously in MACHINERY to the activity of the National Machine Tool Builders' Association in connection with the standardization of parts and dimensions within practicable limits, the economy of which is now recognized by machine tool manufacturers everywhere. Would it not be well to carry standardization a step further and apply it to the selection of names for different classes of machine tools?

Many machine tools of the same type now have different names, some of which are misleading and have little or no explanatory value. The names "turret lathe" and "screw machine" are sometimes applied to machines of the same type; drilling machines are also known as "drill presses" or "drills"; the expressions "face grinder" and "edge grinder" are used to designate the same type of machine, which is also true of the names "vertical turret lathe" and "side-head boring mill." The "flat turret lathe" and the "turntable lathe" are similar, as are "multiple-spindle horizontal milling machines" and "rail milling machines." Names such as "grinder," "grinding machine" and "floor grinder," as applied to corresponding types, are confusing and lacking in descriptiveness.

The term "automatic screw machine," though sanctioned by common usage, is a misnomer, and "automatic," as a substitute, is too indefinite. Machines designed primarily for threading bolts and rods are either "threading machines" or, more commonly, "bolt cutters." "Slabbing machines" and "rotary planers" are similar, according to some classifications. "Power hacksaws" are also known as "metal-cutting machines," and the names given to certain other classes of cutting-off machines do not indicate whether the machine is of the cutting-off tool or saw type. There is also room for improvement in selecting names for some gear-cutting machines, as well as tool grinding machines and multiple-spindle drilling machines of different designs. The use of "high-sounding" names should be avoided, especially when accuracy is sacrificed. For instance, many machines are classified as "automatic," when they are strictly semi-automatic.

Buyers frequently refer to a classified product index or directory to obtain the names of firms manufacturing various types of machine tools, and standard names, selected with reference both to their descriptive qualities and the most prevalent usage, would prevent much confusion. A reasonable degree of name standardization would be worth whatever effort might be required to bring about such an improvement.

* * *

ARRANGING SHOP EQUIPMENT

Every shop executive knows that machine tools and other shop equipment should be so arranged that the material to be machined may travel through the shop by the most direct route; the ideal arrangement is that which permits every part to move from the stock-rooms through the machining departments to the shipping department in as nearly a straight line as possible. To obtain this result very careful planning is necessary in locating the different departments in the shop and the machines within each department. Two methods are generally used to group machine tools so as to simplify the travel of the material through the plant.

Under one method all the machines of a certain class are placed in one group or department. For example, lathes should be in one place, drilling machines in another, automatic screw machines in a third, etc. Under this grouping method the departments are located so that the material passes from department to department in the order of the operations to be performed on it, the departments, as far as possible, being located so as to eliminate the trucking of material back and forth.

When the work to be handled is comparatively large, a second method sometimes known as "process grouping" is frequently used. In this case machines of different types may be placed in a group in the same department in such order as to complete a part without moving it from the group. For example, if a part is to be turned, planed, milled and drilled, four machines for performing these operations may be placed in a group. This plan will save considerable handling of heavy pieces, but is applicable as a rule only when the product of the plant remains practically the same from year to year.

The grouping of machines of one type in each department is more economical when the work is small, and when changes in the design or character of the product are likely to be made; it also makes it possible to have an expert in charge of each class of machines. The second method is better for heavy work, particularly when it is of a uniform and permanent character.

* * *

TWO FACTORS IN SAFETY WORK

The campaign started some ten years ago to provide safer working conditions in shops and factories has resulted in the adoption of many safety devices which have materially reduced the number of accidents. Manufacturers of machine tools and other shop equipment have provided guards to prevent the operator from coming into contact with any dangerous moving parts. Ingenious safety appliances have been incorporated in the design of power presses, because the operators of these machines probably are exposed to greater dangers than those handling other types of machine tools. But the provision of guards and other safety appliances and the instruction in their use, is but one factor in safety work. The other is the assurance that the operators will make such use of the safeguards that they will be shielded effectually from accident.

In a large press shop a man was recently injured by having the fingers of one hand crushed between the dies. Every press in that factory was equipped with a safety device so arranged that in order to release the clutch and bring down the upper die, it was necessary to operate two levers, one being actuated by each of the workman's hands. In the circumstances, it seemed impossible for the operator to expose either of his hands to injury, as both had to be out of the way when the die descended; but examination of the machine referred to showed that the operator had tied down one of the levers so that he was able to trip the press by operating only one handle. In other words, he had taken the trouble to render inoperative the provision for his safety installed at considerable expense by the company. Little can be done to eliminate accidents to operators who deliberately take such chances and will not listen either to advice or instruction. They take their lives in their own hands.

Prices, Wages and Cost of Materials

By F. N. MACLEOD, President, Abrasive Machine Tool Co., East Providence, R. I.

LET it be said right at the start that increased prices of machine tools are necessary if this American industry is to permanently maintain the high standards for which it has been known for a generation. The low prices prevailing today, due to keen and sometimes destructive competition, in most branches of the machine tool industry, cannot prevail for long. Increases must be made to meet the higher costs of today as compared with pre-war days. Any return to pre-war figures would entail a return to pre-war wages, pre-war taxes, pre-war railroad rates, pre-war material prices, or in a word, to a pre-war status in every respect, which every reasonable person knows to be an impossibility.

The Question of Wages

It is true that wages in the machine tool industry at the present time are practically twice what they were before the war, expressed in dollars and cents, but when compared with the wages paid in other industries demanding equal skill it cannot be said that they are high. The machine tool industry demands an intelligent, loyal, and skilled body of men. Men of this caliber must be paid more than a mere living wage. During the war, wages and prices in this industry advanced in practically the same ratio, and as living cost—expressed as a whole—has somewhat receded from its peak, wages in this industry have been reduced in a greater proportion. In many other industries (for example, the textile and leather industries, where selling prices during the war tripled and quadrupled) wages advanced in much greater proportion than in the machine tool industry. As a result, mill employes who in the past were paid less than machinists, have, during the last three or four years been paid as much as and in many cases more than the prevailing rate for a skilled mechanic. The skill and knowledge demanded of good machinists and toolmakers certainly entitle them to a higher reward than is paid to the comparatively unskilled labor of the textile and some other industries.

They are not now receiving these wages, and the industry is suffering as a consequence. It will continue to suffer more and more as years go on, unless the machine tool builder insists upon higher prices for his product and a reasonable profit, which will enable him to pay higher wages and thereby attract a better class of workers, thus elevating the industry to the plane to which its importance entitles it. Unless this is done, it will also be difficult to attract the right sort of apprentices to this industry, as they must have something better than a mere existence to look forward to in life.

Present Wages and Fixed Charges Increase the Cost of Manufacture

It might be said that the machine tool business is a separate and distinct industry in so far as the mechanics employed are concerned; it demands a good education and a high order of intelligence, as well as loyalty, and to attract a desirable type of employe it will be necessary to remunerate him at least equally as well as other industries requiring skilled labor. This is as much to the interest of the buyers and users of machine tools as it is to the manufacturers. The tool builder makes but one profit out of his product whereas the purchaser of his machines is deriving a continual income therefrom; consequently it is to his interest that the tools purchased should be of the best workmanship and of the most enduring nature.

The fixed charges that really constitute the main item of overhead in a machine shop have increased during the last ten years in a far greater ratio than either prices or wages. Federal, state and municipal taxes today mount to figures that would have been considered impossible ten years ago. Freight rates are from 50 to 75 per cent higher, and selling expenses have increased, due to many causes, not the least of which is the nearly doubled railroad fares and hotel expenses. The dealers' commissions have been increased in nearly every instance, and the buyer demands more free service and credit extension than ever before. These two items alone add a considerable sum to the total expense of doing business.

A fact that should not be overlooked is that the part of the overhead chargeable to each machine or unit built is much greater today than it was three years ago when tool shops were running to capacity. Another item entering into this load of overhead expense is the amount chargeable to idle buildings and equipment, which unfortunately is not usually taken into consideration. This overhead has to be paid, and while machine tool builders in their competitive efforts have reduced prices to a point where a smaller part of this overhead is paid by the customer than was the case three years ago, the manufacturer in the meantime has been using up his surplus in taking care of this additional load. This condition certainly cannot continue. The time is at hand when the selling price must include the total overhead, even when production is comparatively small, and price increases seem to be necessary in the machine tool field in order to cover all these increased costs which the changed conditions have brought about.

Cost of Material

The cost of material entering into the construction of machine tools is in most cases a comparatively small item among the total costs—that is, a slight fluctuation of 10 or 20 per cent in the price of the raw materials would not materially affect the total selling price, probably not more than 2 to 4 per cent.. Nevertheless, with materials approximately 25 to 50 per cent above the pre-war level, this item alone adds from 5 to 10 per cent to the actual cost of the machine, and with freight rates considered in addition, the total increase is a material factor.

The cost of power to operate a machine shop today is about twice what it was prior to 1914—at least in the districts located far from the coal mines. Here, again, the high freight rates add materially to the fuel cost. The list could be continued indefinitely, since practically every item entering into machine tool production has increased by a much greater percentage over the pre-war level than present machine tool prices have, as compared with pre-war figures.

Machine Tool Prices Must Advance

To sum up, it may be said that if the industry is to continue to spend money on the development of better types of machine tools, for which skilled workers will be required—with both skilled brain and skilled hand—the industry must be placed in a position where it can pay wages commensurate with the type of men required. With this end in view, machine tool prices must advance.

It is not a question of whether machine tools are to be reduced any further. It is a question of *how much* they are to be *increased*. The buyers and users of machinery must realize that they cannot "squeeze blood out of a turnip," and that the present low prices are not based upon production costs, but are purely the result of keen, not to say ruinous, competition in an overstocked market. Even though machine tools were considerably advanced in price during the war period, the increases were nowhere nearly equal to the increases in other commodities, such as shoes, clothing, etc. Hence, such a drastic deflation as should take place in some of these other industries is an impossibility in the machine tool business, nor should there be any advocacy of reducing wages in this field where the workers are already paid much less than those engaged in the building, transportation, printing, and clothing trades.

It should be impressed upon every buyer and user of machine tools that it is in their interest to maintain a high standard of workmanship in the machine tool industry, because their profits are directly dependent upon the standard of machine tools that the American machine tool industry will produce in the future. High-grade men can only be attracted to this industry by maintaining a reasonable rate of wages. It is merely repeating a thought that has often been expressed and that ought to be thoroughly understood by everyone in the machine shop field, that the development and improvement in machine tools is the keystone upon which the prosperity of all other industries depends. Users of machine tools can increase their output and thereby reduce their costs by the introduction of highly productive machines, and they should be willing to pay the price for the service which is rendered.

* * *

MACHINE TOOL EXHIBITION IN NEW HAVEN

Plans are being made for an exhibition of machine tools and appliances to be held in the Mason Laboratory of the Sheffield Scientific School, Yale University, New Haven, Conn., September 21 to 23. The exhibition will be held under the joint auspices of the New Haven branch of the American Society of Mechanical Engineers and the Department of Mechanical Engineering of Yale University. The purpose is to bring before the manufacturers of Connecticut and the engineering students of the university the latest developments in machine tool practice. There is no charge for space, and no admission fee for spectators, as the exhibition committee is giving the exhibition as a means of stimulating industry and hastening the return of normal business conditions. Papers relating to machine shop subjects will be read each evening by men well known in the industry. Exhibitors are also invited to show motion pictures of their machines and appliances and to have representatives present to demonstrate and explain the operation of the machines exhibited. The privilege to exhibit is by invitation only—about 150 invitations having been issued.

* * *

MEETING OF SECRETARIES OF NATIONAL METAL TRADES ASSOCIATION

The local branch secretaries of the National Metal Trades Association met August 16 and 17 at Milwaukee, Wis., for their semi-annual conference. Among the papers read and discussed were the following: "An Up-to-date Employment Bureau," by Chester M. Culver; "Objections to Legislation Favoring Unemployment, Health Insurance, and Old Age Pensions," by J. M. Manly; "Experience of the Grand Rapids Branch of the National Metal Trades Association with their Mutual Workman's Compensation Insurance Bureau," by A. W. Blodgett; "Comparative Wage Schedules," by W. J. Cronin; "Need and Value of Economic Education of Employes," by Donald Tulloch; and "Turnover—Causes and Remedy," by T. G. Silkman.

CONVENTION OF THE STEEL TREATING AND DROP-FORGING SOCIETIES

During the entire week of October 2 to 7 the American Society for Steel Treating and the American Drop-Forging Institute will hold their respective conventions in Detroit, Mich., with headquarters in the General Motors Bldg. In connection with these conventions the fourth international steel exposition will be held. Practically all of the 50,000 square feet available for display space has been sold, and the exposition is expected to be the largest of its kind ever held. Both gas and electrical furnaces will be shown in operation, and many other exhibits may be viewed in working condition.

Technical Sessions

The technical sessions of the convention will be held October 3 to 6, when papers on a great number of subjects of interest to those treating steels and making drop-forgings will be read. Among the many subjects that will be taken up are problems of casehardening, electric furnaces, formation of scale, heat-treatment of automobile springs, tool steels and their structure, and heat-treatment and properties of duralumin. There will also be a symposium on hardness testing, dealing with many of the problems involved in proper hardness testing methods. Papers will be read on the significance of hardness tests, and on hardness and its relation to magnetic properties.

During the convention, arrangements will be made to visit some of the leading automobile plants and other well-known shops in Detroit, including the Ford Motor Co. (both the Highland Park plant and the River Ridge plant), the Cadillac Motor Car Co., the Lincoln Motor Car Co. and the Hudson Motor Car Co. Visits to the Detroit Twist Drill Co., the Central Forge & Gear Co., and the Detroit Steel Products Co. have also been arranged for. The visits to the plants will be distributed over four days of the convention, two plants being visited each day, so as to prevent overlapping and give everybody an opportunity to visit the plants in which they are most interested.

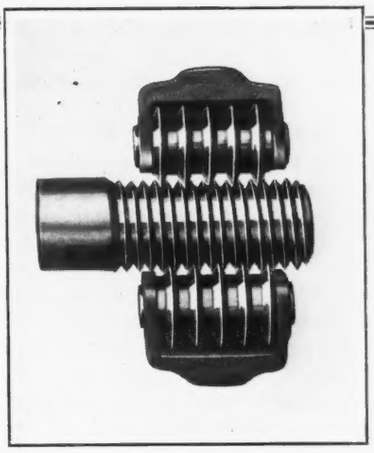
Another feature of the convention will be a symposium on metallurgical education. There have been many requests from members of the American Society for Steel Treating engaged in the teaching profession for a conference with metallurgical engineers, so that the universities and colleges might better prepare their students for the greatest possible usefulness in practical work. At this conference it is not proposed to discuss how to teach metallurgy, but to dwell upon what metallurgical subjects should receive the greatest emphasis.

Officers of American Society for Steel Treating

The election of the following officers of the American Society for Steel Treating has been announced: President, T. D. Lynch, research engineer, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.; second vice-president, W. S. Bidle, president, W. S. Bidle Co., Cleveland, Ohio; secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio; director, S. M. Havens, assistant treasurer and manager, Ingalls-Shepard Division, Wyman Gordon Co., Harvey, Ill. The following officers remain in office from last year: First vice-president, R. J. Allen, metallurgist, Rolls-Royce Co. of America, Springfield, Mass.; treasurer, J. V. Emmons, metallurgist, Cleveland Twist Drill Co., Cleveland, Ohio; director, J. J. Crowe, metallurgist, Philadelphia Navy Yard, Philadelphia, Pa.; director, A. E. White, past president, and director of the Engineering Research University of Michigan, Ann Arbor, Mich.; director, F. P. Gilligan, past president, and secretary-treasurer of Henry Souther Engineering Co., Hartford, Conn. The board of directors of the society is composed of all the officers. The new board will enter upon its duties at the close of the annual convention.

New Type of Adjustable Thread Snap Gage

By CHARLES G. JOHNSON, General Manager, John-Sons Gage Works, Hartford, Conn.

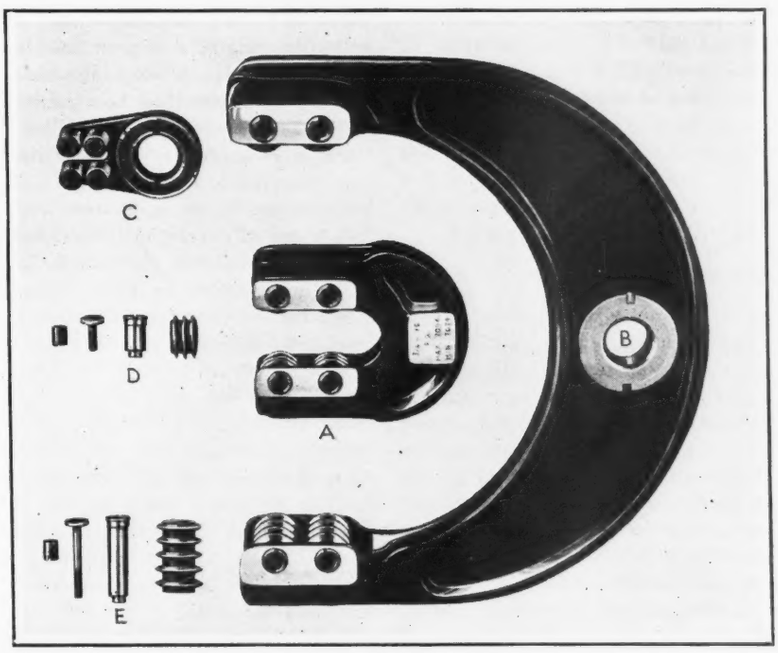


ONE advantage of snap gages is that the sense of feeling need not be entirely relied upon in checking a part, as the sense of sight may also be used. The relation between the gaging elements and the part being inspected may be determined by the amount of light showing between their contact surfaces. Light passes through a very small opening, but is shut out entirely where contact exists. The design of a given snap gage, has a considerable effect, of course, on the extent to which the sense of sight may be employed. The John-Sons Gage Works, 67 Blue Hills Ave., Hartford, Conn., in placing on the market an adjustable thread snap gage made in the styles here illustrated, has provided a means of employing both the sense of touch and the sense of sight in inspecting the different elements of male threads either individually or collectively. By "elements" is meant the size, lead, thread form, concentricity, and straightness of the part.

This gage is provided with two sets of gaging rolls for the "Go" and "Not Go" inspection of parts, the outer rolls being the "Go" set and the inner ones the "Not Go" set. Each roll has a series of annular ribs of the same form as the thread to be inspected, and these ribs are spaced to project between every second thread. Left- or right-hand threads and single or double threads may be gaged because of the fact that the annular ribs on the rolls have no helix angle. The rolls are free to rotate on their axes, a feature that provides for the distribution of wear over a large surface and consequently lengthens the life of the gage. By using one rib on each roll of a set, the pitch diameter of a thread can be accurately determined, and by using the entire length of the rolls the accuracy of the thread form and the lead and the presence of any taper can be ascertained. A staggered thread or one out of round may be detected by rotating the part between the rolls. In the heading illustration is shown clearly the existence of an inaccuracy in the lead of a U. S. standard die cut thread.

Other advantages of this thread snap gage are that it can be used for inspecting work in motion, and work cannot be cramped between the gaging rolls. The latter are interchangeable to provide for inspecting threads of the same diameter but of different pitch with the same gage. The rolls of a set are also adjustable toward one another a total distance of 0.040 inch. This adjustment is obtained by rotating the eccentric bushing upon which each roll is mounted. The rolls are set correctly by the use of a master thread plug which is left soft because no wear results from making the settings. After adjusting the rolls, they are locked in place by tightening a binding screw.

The gaging rolls of Style *A* are approximately ⅜ inch in length, and those of Style *B* are 1 inch long. Style *A* is recommended as being the most suitable for general application except in cases where a long thread must be positively checked for lead and for threads having a pitch coarser than ten threads per inch. Style *C* is made for gaging A.S.M.E. threads from No. 0 to 12, inclusive. The group of details *D* belong to Style *A*, and those in group *E* to Style *B*. The frame of each gage is a heat-treated iron casting.



Different Styles of Adjustable Snap Gages for inspecting the Elements of Male Threads

* * *

BALANCING PLANT EQUIPMENT

A factor in shop operation that is not always given the attention it deserves, is a proper balance of the machine and tool equipment. Sometimes a shop has too many of one type of machine tools and too few of another. In buying equipment, a careful study should be made of the capacity of each machine, so that the output of all the machines may be equalized—that is, so that various parts may be produced in the right proportion; otherwise, some parts will be made in too large quantities, while others will be insufficient in numbers, and some operations will always be far ahead of others. If the probable production required from the plant is first estimated and then the probable production of each machine determined, it will be possible to estimate accurately the number of machines required to handle a given production. If this is not done, some departments will be required to work over-time in order to catch up with the production in other departments.

Sometimes the machine equipment is properly balanced, but production is crippled, due to incompetent supervision of certain departments or faulty operation of the equipment. Things of this kind can be remedied only by a thorough study of all the departments.

The Future of American Machinery and Tools in Europe

By A. L. VALENTINE, formerly "Directeur technique" of the Societe des Usines Curial, Paris, France*

PREVIOUS to the war there were few European mechanical engineers who were not convinced and willing to admit that American machinery and tools were superior to those made in any other country. After the armistice, and especially during the last two years, the machine tool and small tool industry in some of the European countries has rapidly developed, and there is danger of a change of opinions, especially in France and Belgium, and also in Italy and Spain. Before the war the price of the American product was low enough so that it could easily compete with any domestic machinery and tools. At the present time this situation with regard to price does not exist, and consequently the sales of American products in this field —especially small tools—are very small. American manufacturers have attributed the limited sales almost entirely to adverse exchange conditions, but other even more important factors have also had a very great influence.

The writer believes that wher the rates of exchange have been finally stabilized, there still will be a comparatively small market in Europe for American machine tools and small tools. He bases this opinion upon his experience during the last three years, when he was in a position to study the situation in all its phases intimately, not only in France but in other European countries as well. It appears that there is only one means by which American manufacturers may continue to retain their hold upon the European market in this field, and that is by manufacturing in branch factories in Europe, a subject which will be dealt with in greater detail later. Several months ago one prominent American manufacturer took steps in this direction, and in the near future will produce his tools in one of the European countries for the European market; there are to his knowledge at least, two other manufacturers who are now making investigations with the same aim in view.

The author of this article has had an unusual opportunity to gain first-hand information with regard to the machine and tool situation in continental Europe. For the last three years he has been "Directeur technique" of the Societe des Usines Curial in Paris, for which company he built and equipped one of the most modern small tool factories on the European continent. In preparing this article, he has availed himself of the assistance and opinions of one of the best known sellers of American machine tools in Belgium, who is connected with one of the foremost European dealers—a man who is considered an expert in his line and who knows intimately the commercial side of the European market for American machine tools and small tools. Mr. Valentine, before his engagement in France, was for fifteen years superintendent of the Small Tool Division of the Pratt & Whitney Co., Hartford, Conn.

Stocks of Machine Tools in France

A thorough explanation of the causes which tend to curtail the market for American machinery and tools in Europe goes back to the time when the armistice was signed. At the end of the war the allied nations reduced their imports because of the tremendous shipments that had been received by them during the war, and those that were actually on the way at that time, all of which would first have to be put to peaceful use before there would be a further demand. If all other conditions had remained as before the war, there would, however, only have been a temporary falling off in demand; and had business and exchange remained normal, even the great quantities of machines in good condition that were available would soon have been absorbed. Due to the business crisis on the continent, there are even at this time, especially in France, large quantities of machinery and tools still to be disposed of. Right outside of Paris there are large warehouses filled with unused machine tools and other machinery remaining from the surplus stock of the war. These warehouses equal in extent the size of a machine tool plant that would employ between 3000 or 4000 men, this comparison being given in order to furnish an idea of the quantity of machinery available. It will be long before this machinery is absorbed by French industries.

The Manufacture of Machines and Tools in Europe

The surplus stocks, however, are not the most serious factor in the situation. During the war a few French and Italian manufacturers established departments in their own shops, in which they not only manufactured their own machines and tools but also started to make for the market as well. When the armistice was signed, quite a number of firms were in a position to furnish satisfactory equipment of all kinds to the domestic market. In the three years following the armistice, a very important machine and tool industry was developed in France and Belgium, and to some extent in Italy; in the small tool field especially, there has been great activity. It ought also to be mentioned in this connection that as far as France, Belgium, and Italy are concerned, there has been very little actual copying of American machines and tools.

The high rate of exchange has encouraged these firms, but it is problematical how many of them will be able to hold their markets permanently against American and German competition. Nevertheless, while many of these new concerns have already failed owing to the unstabilized business conditions in Europe, and while several more will fail, there is a substantial number who have the financial strength to weather the storms, and who will succeed and grow more active as time passes. The competition they will offer will severely influence the market for American machines; to quote verbatim a prominent seller of American machine tools in Europe: "There is at present a strong tendency on the part of our customers to buy machines made by their own countrymen. with the conviction that they buy good machines well adapted for their requirements. Such machines are particularly planers, shapers, upright drilling machines, radial drilling machines, vertical boring mills, lathes of all kinds, punching and shearing machines, drop-hammers, foundry equipment, pneumatic tools, electric and air drills, and air compressors. The only American machines for which I can see a future market in Europe are certain classes of milling machines and grinding ma-

*Present address: P. O. Box 706, Hartford, Conn.

chines, gear cutting machinery, special machinery, and, to a small extent, planers. In the small tool line the situation is still more difficult, because, besides what has been done in France and Belgium, we feel very much the German, Swiss, and Swedish competition."

German Competition Active and Successful

The German competition in measuring tools and measuring instruments of all kinds is especially active, and the tools sold are of a high quality and accurate. Continuing the quotation of the selling expert: "The manufacture of twist drills and reamers has taken on such an important aspect that there is very little room left for the American product, and the prices at present, at least, cannot possibly be met by American competitors. In the manufacture of plain milling cutters, saws, side milling cutters, cutters for cutting gears, and gear hobs, there has also been an important development in France and Italy, and there are several manufacturers capable of producing as good tools as those made in America. The workmanship and the quality of the steel employed in the manufacture of these tools compare well with those of any American make."

The writer himself has had an opportunity to compare cutters for cutting gears of American and German make, and has found that the German tools are remarkably accurate, and at the present time, of course, very much cheaper. Imports from Germany into France, Belgium, and Italy are neither encouraged nor popular, but when the quality is equal and the price is lower there is only one course for the buyer to pursue. The natural result is an ever-increasing effort on the part of the people in France, Belgium and Italy to meet by their own manufactures the competition of the foreign product by quality as well as price, and a visit of American manufacturers to some of the French and Belgian shops where machine tools and small tools are made would prove a revelation. In this way only can the real situation be understood thoroughly and it would be appreciated that the competition can be met only by actual manufacture of American designs in Europe.

The Present Development of the French Industry

The extent to which the national spirit has been aroused in Europe by the war has also given a tremendous impetus to all commercial and industrial activities. Plans are now being made in France for the manufacture of small tools in greater quantities than before, and it seems safe to say that it is only a question of a couple of years before France, Belgium, and Italy will be able to supply themselves with everything they need in the small tool line—except possibly in the line of precision tools, as there has been no real effort made as yet to produce tools of this kind, because the market is comparatively small. But the capacity of the French, particularly, for producing precision tools, if the need arises, is unquestioned; and when their manufacturing industries have been placed on a basis of mass production, they will doubtless turn out precision tools and instruments that will be on a par with those made in America, Germany, and Switzerland.

It should not be overlooked that in addition to the difficulties caused by the exchange situation, European manufacturers are largely assisted in their efforts to introduce their products in their home markets by the lack of quality in some of the machine tools and small tools which were shipped to Europe during the war and during the boom period after the war. Some firms whose reputation before the war was of the very highest, injured their standing considerably during the war, and the new firms that have sprung up in Europe to manufacture competing lines have taken every advantage of the situation. It is of the utmost importance that there be no deterioration in the quality of American machine tools supplied to the European market. As a matter of fact, the European buyer today is more insistent upon quality and accuracy than ever before.

How to Hold the European Trade

In the writer's opinion (and he is supported not only by dealers in machine tools but by prominent industrial men in both France and Belgium) there is only one way in which American manufacturers can compete in the European market, and that is by manufacturing in Europe and by beginning to do so now, before it becomes too late. The advantages obtained would be the reduction of costs due to eliminating freight charges, customs dues, and insurance; and the use of the much cheaper European workmen, who, when properly guided, and with the work properly systematized, show a remarkable aptitude, and who, when given the proper equipment, actually produce more than the majority of American workers. The continental labor conditions today are very much better and more favorable than those in the United States. The raw materials are cheaper, and the quality fully as good. High-speed steel, particularly, is excellent. The expense of stocking machines with agencies should also be considered. At present the agencies, as a rule, do not carry in stock a sufficient quantity of machines and tools.

The market for cutters and reamers and even twist drills could be regained quite easily by equipping factories in France with special American machinery and placing a few American specialists in charge. The market for taps and dies could easily be held by this means, because that market is as yet not captured by the European manufacturer, although there are two firms who are working very earnestly toward supplying the domestic demand in this line.

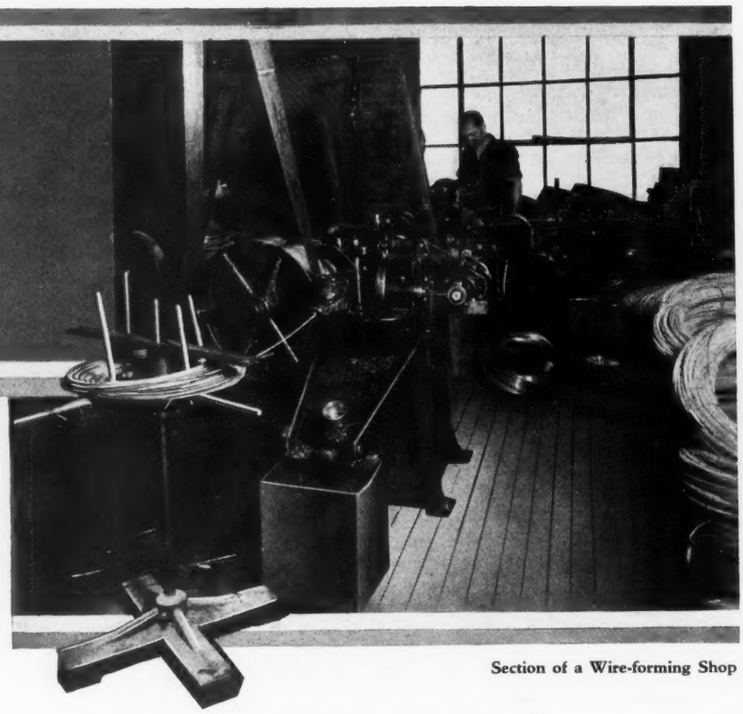
It would seem that American manufacturers would have everything to gain by a radical change in their attitude toward the European market. The high rate of exchange would enable an American manufacturer to build or buy factories abroad at a price that would appear to be comparatively cheap. The appearance of well-known, well-equipped and financially strong American firms in these three countries, producing machines and tools of high reputation, accuracy and quality, would soon discourage any attempts to start new European concerns in this field.

* * *

BILL TO REDUCE PASSPORT FEES

Commercial travelers abroad have found the large passport fees payable in the United States and abroad a heavy burden. Steps are now being taken, through the introduction of a bill in Congress by Representative Mills of New York, for reducing the passport fees assessed by the United States Government. This will reduce immediately the passport visé fees of the countries which have a standing provision that their fees are the same to citizens of any country as the amount assessed to their nationals by that country. Other countries who have raised their passport fees will doubtless reduce them if the United States leads the way. Under the terms of the bill, a passport would be issued to an American citizen for $5, valid for two years; and the fee for viséing passports would be reduced from $10 to $2. Those interested in this measure may communicate with the Chairman of the House Committee on Foreign Affairs, the Honorable Stephen G. Porter, and the Chairman of the Senate Committee on Foreign Relations, the Honorable Henry Cabot Lodge. The bill is known as H.R. 12235, and it is believed that its enactment would be of material aid to international trade. All nations realize the burdensome tax imposed by the passport fees, but they all followed the lead of the United States in imposing this tax upon travel. It is certain that other nations would gladly follow if the United States would lead the way in reducing this burden.

Wire Forming



Section of a Wire-forming Shop

Second of Two Articles Dealing with the Methods Used in the Manufacture of Wire Goods and the General Principles Applied in the Design of Typical Wire-forming Machines

IN the first article on this subject, published in August MACHINERY, the basic principles of wire forming, forming dies, and tooling methods for the production of wire articles were presented, supplemented by examples of wire forming. In the present installment, articles that require special arrangements of tools and ways of operating them are dealt with. All wire forming is, in a greater or less degree, special, and it would be possible to select a great many examples, each of special interest and containing unique manufacturing processes, but those here shown are typical of the nature of the work. The practice described is that of the Eastern Tool & Mfg. Co., Bloomfield, N. J.

Making an Over-all Slide

The manufacture of the over-all slide shown in the upper left-hand corner of Fig. 6 involves wire-forming work of an interesting nature and calls for the application of many of the principles of wire forming which were noted in the previous installment of this article. The slides are made from soft steel square drawn wire, No. 15 W & M gage (0.072 inch). The work is done on a No. 2 Nilson wire-forming machine and is produced complete in one sequence of operations. The wire is fed through the straightener rolls in the regular way and against a stop, at which time it bears against the front surface of the king-post, in the position illustrated in Fig. 7 which shows the incoming wire passing over the completed work before that pieced is stripped from the king-post.

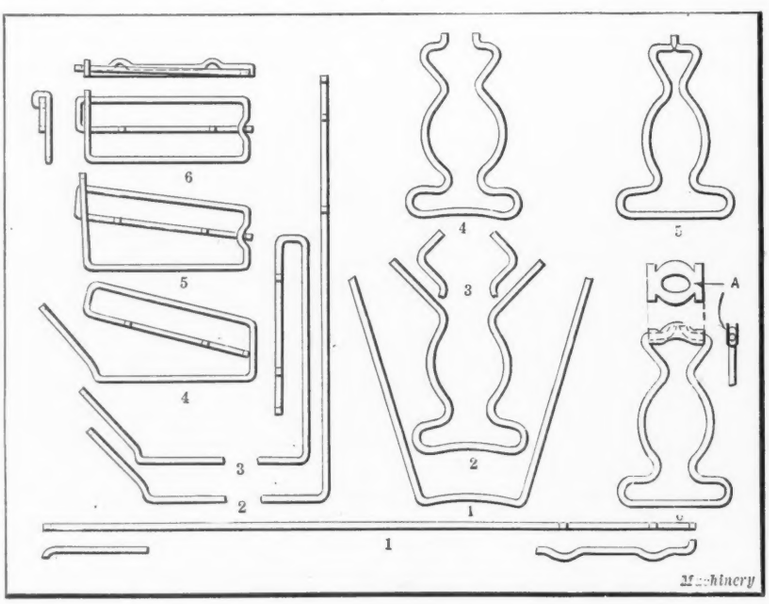


Fig. 6. A Number of Shapes produced in the Manufacture of Wire Slides and Loops for Over-alls

The position of the wire relative to the stop is indicated at *A* in Fig. 9 where it first rests on a step preparatory to bending the crimps and the hook end. It is necesssary to prevent the wire from sagging so that it will rest on this step, and for this purpose a guide is employed the end of which is barely visible from the right-hand side of the machine at *A*, Fig. 8. The front opening of this guide is V-shaped so that the end of the wire can readily ride into the locating slot, where it is engaged by a small spring finger from beneath, which properly locates the wire at the level of the step mentioned. The die for forming this end of the wire is visible at *B*. This die and the cut-off *A* (see Fig. 7) operate in unison, and the cut-off is designed with a shoulder for the purpose of producing a bend in the end of the stock after it has been severed. The shape produced in the first operation is indicated in the illustration Fig. 6, which also shows the work in the six different stages of its manufacture.

The front die shown at *B* in Fig. 7 is next advanced and bends the wire with the aid of the king-post, into the shape indicated in Fig. 6 and also in the diagrammatic lay-out, Fig. 9. In this illustration the lower end of the king-post around which the completed work is to be formed is indicated at *B*. The front die *C* contains a groove by means of which the wire is located in one plane during all subsequent forming operations. This groove produces a right-angle bend at one end, and, by reason of a cut-away corner in the groove, an

angular bend in the opposite end. This angular bend is produced for a special purpose and the slide could not be formed, at least according to the methods here described, unless this angular bend were first produced. The wire that forms the 90-degree angle sweeps around until it rides up the top surface of a screw-head *D* which contains a slot in which the wire becomes lodged. The wire is prevented from becoming dislocated from this slot during the next bending operation by a spring wire, the end of which is arranged about as shown at *F*.

The under side of the front die is cut away below the groove. This is done to permit the final forming of the slide. The wire is held by the front die and by the slot in the screw *D* while the next bending operation occurs, which is performed by an auxiliary lever *A*, Fig. 10, which is designed to fulcrum by means of lever *B*, connected to an auxiliary cam on the regular camshaft at the right-hand side of the machine. This lever has a specially shaped nose, which insures that the wire will become directly engaged by the lever, regardless of any slight misalignment with the slot in the end of the lever.

The auxiliary cam is shown at *C*, Fig. 8, in which illustration the pivoted lever *D* and its connection to the auxiliary slide may be seen. This illustration shows the lever as the bend is in process of completion and calls attention to the need of special means for holding the stock in the groove of the screw-head while the bend is occurring. This is necessary because as the stock is being bent, its outer end rides up the sloping surface of the back die, *J*, Fig. 10. This illustration furnishes in graphic manner the relative positions of the dies at this stage of manufacture.

The position of the auxiliary lever shown in Fig. 8 at *D* is indicated in broken outline in this diagrammatic illustration and its position at the completion of the bend at *A*. As the end of the wire sweeps over the sloping surface of the back die *J*, this end will become slightly bent so that the hairpin loop will be completed with one end bent slightly askew.

Before the purpose of this intermediary bend can be understood, a clear idea of the design of the king-post should be had. In Fig. 10, a top view of the king-post *G* is shown as well as the shape at the lower end around which the wire is formed. Referring to the partial side elevation of the king-post it will be seen that its lower end is shaped with an angular slope *E* which runs into a shelf *F* on which the over-all slide bears during all bending operations. The wire is held against the front of this king-post by the front die so that the hook end of the hairpin loop, which has just been slightly offset upward, will come in contact with this angular surface *E* as shown, as the hairpin loop is completed.

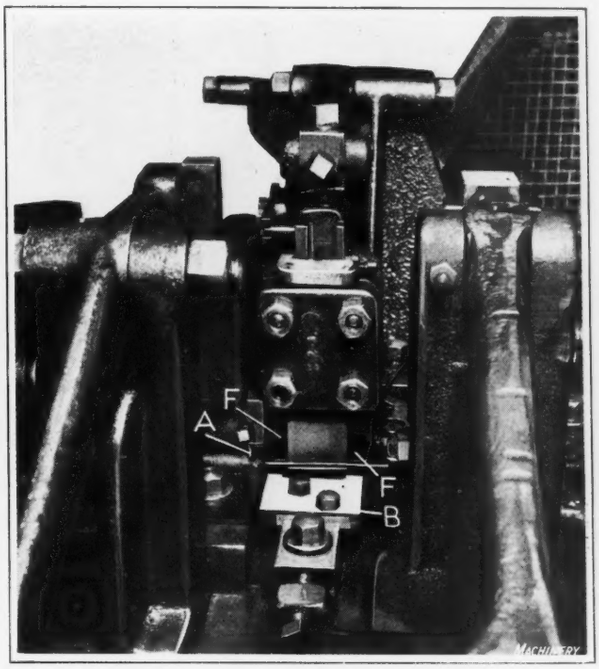


Fig. 7. Front View of Wire-forming Machine showing the Front Die, King-post and Incoming Wire

Shape 4, Fig. 6, is next formed. An auxiliary piece attached to the side of the die *A*, Fig. 11, has a sloping end *D*, to lift the wire out of the screw-head groove in which it was located during the previous operation, and to guide it into the groove in die *A*, as this die proceeds to form the loop into a 90-degree bend. Wherever it is necessary to dislodge a wire or to reposition it in the correct operative plane, extensive use is made in wire-forming work of dies designed in the manner mentioned, or as previously described for the swinging lever *A*, Fig. 10.

The slight bend produced by passing the end of the wire over die *J*, Fig. 10, enables the angular surface *E* to be made abrupt enough so that the hook end of the wire will readily follow down the surface to shelf *F*, as Shape 4 is being made. The result is that this end then becomes offset in the opposite direction owing to the fact that the hook end bears on the shelf, a condition which is necessary in order for it to be subsequently passed under the right-hand end of the slide. This occurs during the advance of the side die *A*, Fig. 11, and before the opposite side die *B* (also shown in Fig. 10) has had an opportunity to come into the operative position.

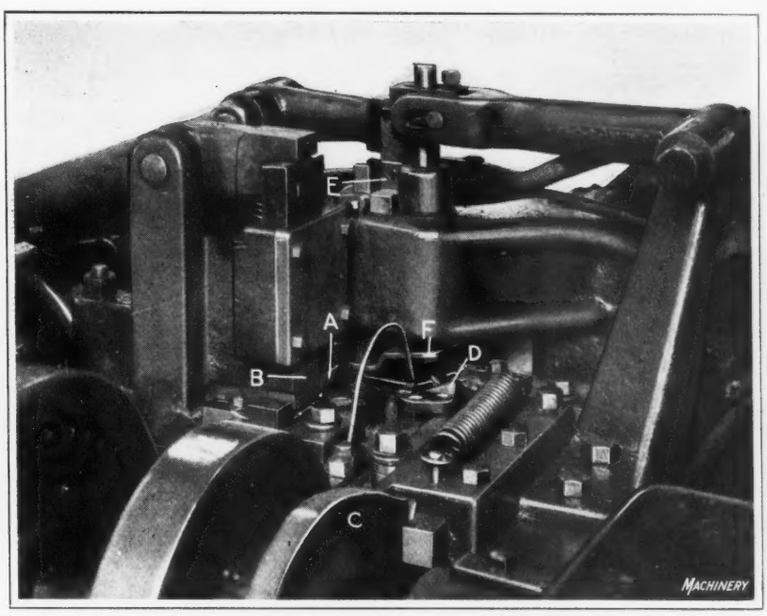


Fig. 8. View of Right-hand Side of a Wire-forming Machine illustrating the Use of an Auxiliary Bending Lever

Figs. 12 and 13 are views taken during the forming of the over-all slide with the aid of a mirror placed beneath the wire-forming machine. The first of these shows the position of the operative parts as they appear from beneath just before the beginning of the operation illustrated in Fig. 8; the second view from below shows the side die completing Shape 4, Fig. 6. In these two illustrations the front die is indicated at *A*, the back die at *B*, the side dies at *C* and *D*, and the

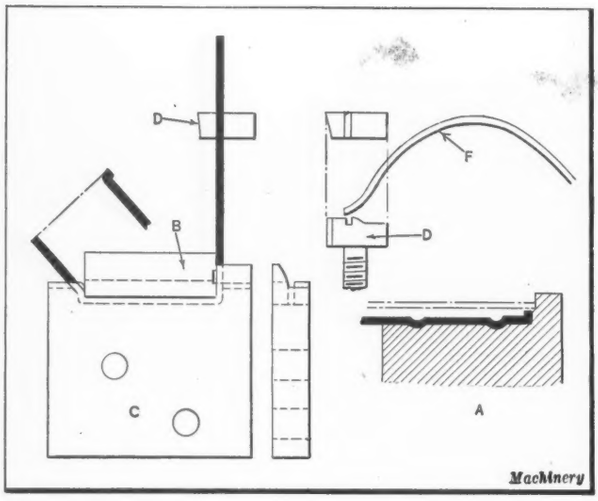


Fig. 9. Diagrammatic Illustration of Stop and Die Positions used in making the First Two Shapes of an Over-all Slide

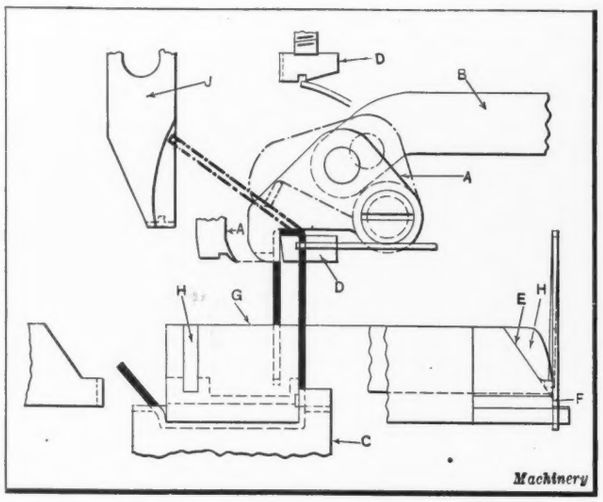


Fig. 10. Lay-out showing Positions of Dies and Work after forming the Over-all Slide into the Shape shown

stripper which surrounds the king-post around which the slide is formed, at *E*.

Final Forming Operations

As the die *A*, Fig. 11, continues to advance it produces Shape 5, Fig. 6, working in conjunction with the die *B* which by this time has advanced and started to complete the bending of the short angular end. The hairpin loop of the wire would strike this angular end and the hook end would not be permitted to pass under the opposite end if provision were not made for avoiding these interferences. This is accomplished by a vertical slide in the king-post. The slide is indicated at *H*, Fig. 10, and its lower end at *F*, Figs. 12 and 13, while the means by which it is operated from the top of the machine is shown in Fig. 8. Here the slide is indicated at *E* and it will be seen that an auxiliary cam-lever is connected to the slide, which actuates its movement as determined by the setting of a special cam provided for the purpose. The slide is brought to bear on the hairpin loop, forcing it slightly downward so that the two side dies may then continue to close the work.

The final movement of die *A*, Fig. 11, just prior to the complete closing of the slide, produces a slight depression in the side of the work into which the hook end of the hairpin loop will snap when the 90-degree bend in the slide has been completed. The king-post contains a shallow groove *E* into which this bend is formed. Die *B* introduces in its design, other principles in wire forming that should never be overlooked. The rear part of the front surface is cut away at an angle so that the working end is just wide enough to pass between the front die and the back die when all are in their advanced positions. The dies remain closed throughout the last operation which is that of curling the end of the wire into its final shape as shown in Fig. 6. The back die *J* which does the curling, produces a thrust at the end of the wire which might cause it to buckle or break if it were not supported, and so die *B* remains in contact with the wire as shown in Fig. 11 until the work is completed.

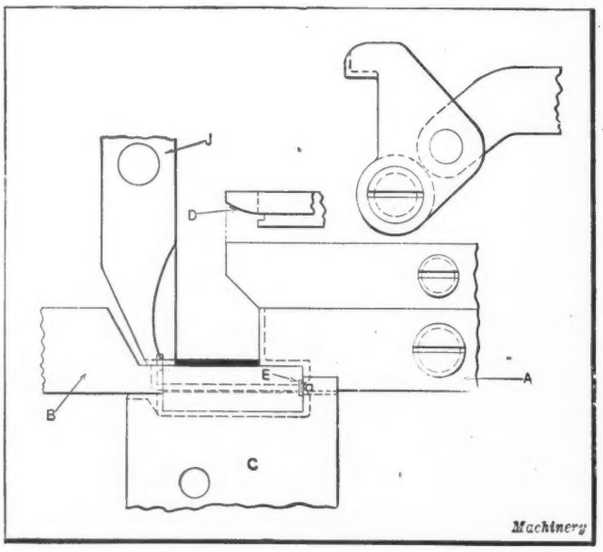


Fig. 11. Closed Position of the Slides after the Work has been completely formed

All the dies then recede, and the stripper which is formed to surround the king-post partially as shown at *F*, Figs. 7 and 8, is depressed, forcing the finished work from the king-post while the wire for the next over-all slide is being fed in over the finished work (see Fig. 7). The machine operates at a speed which will produce 80 finished slides per minute, but the average hourly output is about 3400 pieces.

Forming Over-all Loops

The over-all loop shown in the lower right-hand part of Fig. 6 is formed from 0.075-inch diameter semi-hard cold-drawn steel wire. An E. J. Manville 4-slide wire-forming machine is used to produce the work up to Shape 5, and a specially equipped power press is employed to complete the loop. The arrangements for straightening, feeding, guiding and stopping the wire are the same as those commonly employed on this type of machine. The guide, which is indicated at *A*, Fig. 16, is more clearly shown in this illustration than was possible in the illustrations of previously described tooling arrangements. The work is first bent to Shape 1, Fig. 6, by the front die which remains in its advanced position throughout the remainder of the forming work. As this shape is produced, the ends of the wire sweep over the side dies which are liberally curved at the edge to permit this to occur. The wire which is then in tension, snaps down into its proper plane after passing over the side dies so as to be engaged by the dies as they are brought into operation.

The two pairs of side dies *A* and *B*, Fig. 14, are brought into operation simultaneously to produce the two sharp bends in each side of the work, as the diagram shows. These dies are attached to separate blocks, one of which is shown at *B*, Fig. 16, each adjustably arranged to compensate for wear and for varying sizes of loops. The blocks which carry these die members, each have a cut-out section in which a lever-forming member *C* is located. As the blocks are advanced, the levers *C* are brought into position so that they may be directly operated, in the manner to be described.

These two levers produce

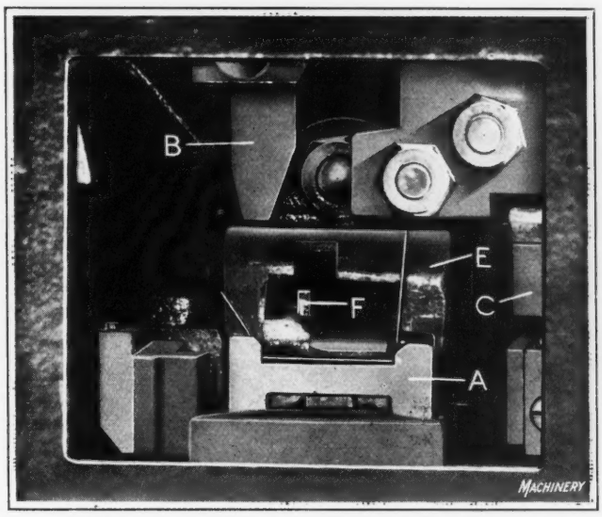


Fig. 12. View from Under Side of the Die Opening of the Machine shown in Fig. 8 with the Dies at Work

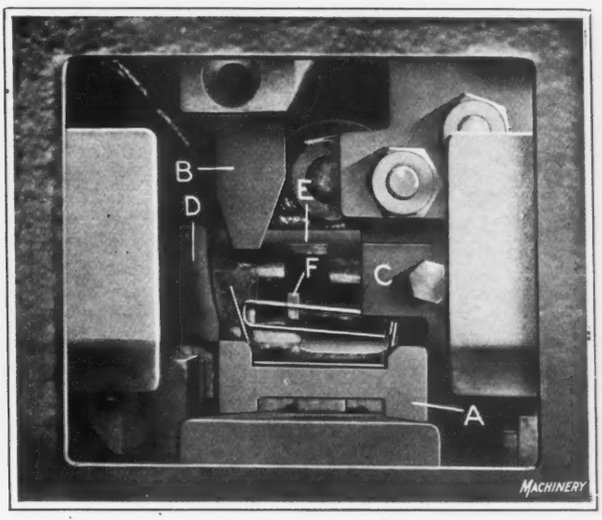


Fig. 13. Another View from Under Side of the Die Opening showing the Advanced Position of the Dies

Shape 3, Fig. 6, and by the time that they have advanced to the position indicated in Fig. 14, the back die *D*, also shown in Fig. 16, has also advanced so as to contact with rollers on the ends of levers *C* and by means of the cam surface on each side of the back die, causes these levers to fulcrum and bend the ends to approximately a 45-degree angle. By this tooling arrangement additional bending dies are brought into play without requiring auxiliary cams for the purpose, and the arrangement is one that may often be employed where the nature of the work will permit. Fig. 15 illustrates the method of producing the two bends at the upper end of the loop. As levers *C* continue to fulcrum, the toe of the lever forms the wire around the king-post sufficiently to bring the ends into alignment with the groove in the end of the die *D*. This die then engages these projecting ends and as it advances, produces the sharp bend shown.

Attention is called to the construction of the king-post at this end, in that a separate piece *F* is attached to the main part of the post which may be readily replaced as wear occurs. This construction is of double importance, in that it simplifies making the king-post and provides for the rapid wear which the sharp corners at this end of the post is subjected to.

The shape thus produced—Shape No. 4—contains a concave bend that is formed by the front die *E*, Figs. 14 and 15. This curvature is designedly produced and introduces the method of shaping the completed article. This end of the king-post is also a separate member *D*, Fig. 18, which is concaved on the front surface. This curvature gradually changes until at its lower extremity it is convexed as shown at the right. Directly in front of the lower part of the king-post there is a guiding member *C* (shown at *E* in Fig. 16) so that as the stripper forces the formed loop down, the concave bend in the wire will be removed by means of the 3-point contact formed by the two lugs on member *C* and the high point on the convex of *D*. The result is that the open ends of the wire close, which produces Shape 5 and completes the forming work.

The two ends not only come together but they overlap, this being done to produce a tension in the wire for engaging the sleeve by means of which the two ends are subsequently assembled. In order to make it possible for these two ends to overlap, the grooves in the separate piece *F*, Fig. 15, are offset an amount approximately equal to the radius of the wire. The production time for this job is about the same as for the over-all slides, that is, 3400 per hour.

Special Equipment for Assembling the Sleeves

The closed ends of the wire loop are assembled into a sheet-metal sleeve *A*, Fig. 6, and the making and assembling of these sleeves is performed on a Baird power press equipped

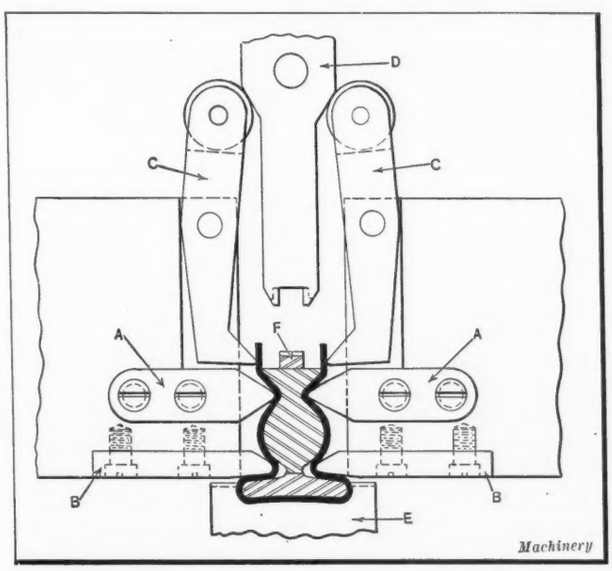


Fig. 14. Lay-out showing the Position of the Dies during the forming of an Over-all Loop

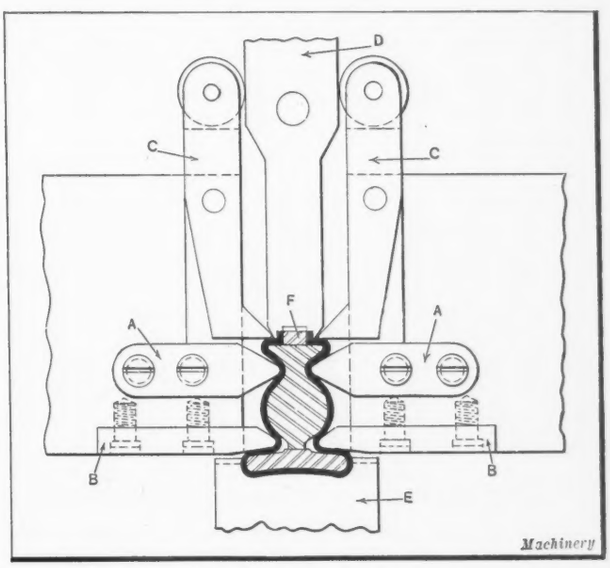


Fig. 15. Position of Dies after the Approximate Shape of the Work has been obtained

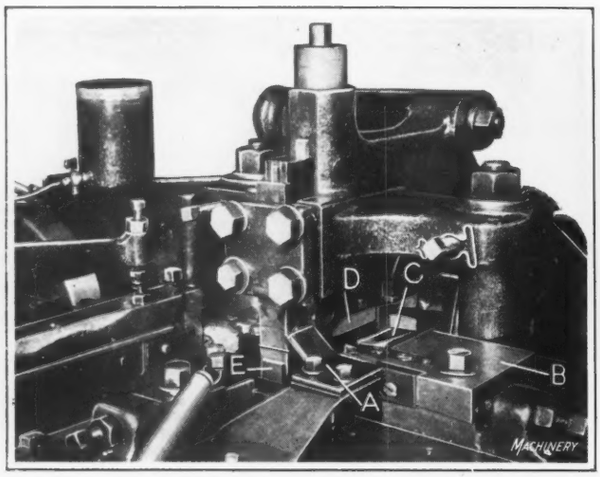


Fig. 16. Front View of Wire-forming Machine set up for making an Over-all Loop

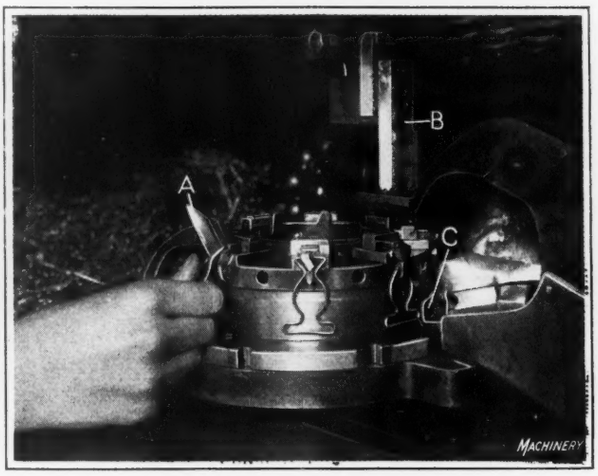


Fig. 17. Dial Fixture used on a Power Press for assembling the Sleeves in Over-all Loops

with a follow-die and a dial fixture. The front of this machine is shown in Fig. 17. The ribbon stock from which these sleeves are made is fed from a coil at the rear, blanked out, punched and bent to a U-shape in the follow-die. With each stroke of the press ram a sleeve is seated in a holder in one of the eight stations of the dial indexing fixture, with the open end uppermost.

The fixture is indexed with every stroke of the press, successively bringing the stations into position under horn *A*. Each sleeve is held tightly in place by a flat spring in back of each station, which bears against the end of a pin extending radially through the holder in which the sleeves are located. The index slide and pawl are located on the opposite side of the machine and operate in the regular manner from an eccentric. As the operator passes the loops over tapered horn *A* they are sprung open to the proper width to permit them to pass into the sleeves, and the tension thus produced has a tendency to force the loops into a vertical position bearing against the base of the fixture, which is the position occupied by two of the loops in the illustration. Lugs projecting from the dial plate assist in holding the ends of the loops apart until the sleeves have been closed around them.

As the work advances into alignment with the closing die *B* attached to the side of the press ram, this member closes the ends of the sleeve around the wire. In the next position the lower end of the work passes through a channel at the end of ejector *C* which is a rocking member, the channel end being raised and lowered with each operation of the press by means of suitable lever connections. The outer wall of the channel is crescent shaped in section, so that the wire can readily pass up the rise of this section as it passes into the channel. The ejector then rocks, causing the loop to snap up out of position and against the covered chute through which it is delivered to a suitable receptacle, completing the manufacture of the over-all loops. This work of assembling the sleeves is performed at the rate of about 2750 per hour.

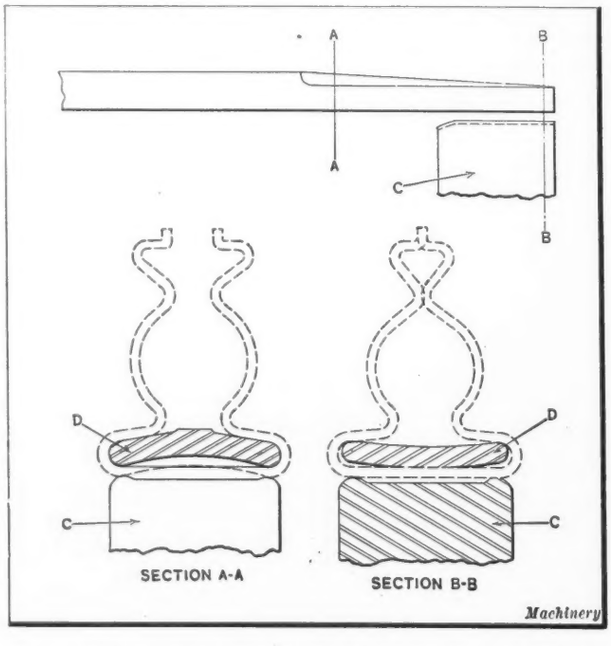


Fig. 18. Specially Shaped Horn attached to the King-post, and Sketches illustrating its Purpose in forming an Over-all Loop

A NATIONAL ENGINEERING MUSEUM

A proposal has been made by the DeLamater-Ericsson Commemoration Committee for the purpose of establishing a national engineering museum. In seeking a permanent place for the DeLamater-Ericsson historical collection, the committee conferred with the Smithsonian Institution at Washington, and in reply the secretary sent his latest report on the National Museum, which is under his custody. The concluding paragraph of this report reads as follows:

"Museums devoted to history, art, and the natural sciences are established in all of the larger nations of the world and many of them have established in addition, educational museums of engineering and industries. Thus England has her South Kensington Museum; France her Conservatoire des Arts et Matiors (at Paris) and Germany her Deutsches Museum (at Munich); but nowhere in this nation of ours, the most advanced in the application of the engineering and mechanical arts, is there a similar institution. The commanding place in the world which the United States has reached in the short space of seventy-five years is due largely to the full development and utilization of mechanical power in the exploitation of her natural resources. It is this that has made it possible for the people in the United Sta[illegible] to enjoy a standard of living far above that under which the peoples of the rest of the world exist, and still no public sign of appreciation either national or otherwise is to be found anywhere. What more suitable monument could there be therefore than a Museum of Engineering, and where could there be found a more logical place for it than as a part of the great National Museum?"

In connection with the annual meeting of the American Society of Mechanical Engineers in New York next December, there will be exhibited a part of the historical collection of the DeLamater-Ericsson committee at the Engineering Societies' Bldg., New York City. H. J. F. Porter is in charge of the exhibition and chairman of the joint committee on the National Engineering Museum.

The Machine Tool Industry in Sweden

THE construction and building of machine tools has probably reached a higher degree of development in Sweden than in any other European country—England and Germany excepted. This is due largely to the fact that Sweden, although one of the smaller countries in Europe, has a highly developed mechanical industry and, for its size, is an important user of machine tools. The following article gives a brief review of the development of the machine tool industry in Sweden, with the names of the leading manufacturers and a brief review of their activities.

The total production of machine tools in Sweden in 1920 amounted to nearly $7,000,000; the value of wood-working machines built in the country exceeded $5,000,000. In the metal-working and wood-working machinery industries, which are generally classified together, the entire number of men employed in 1920 was about 6000. It should be remembered, however, that on account of the industrial depression, 1920 was a poor year in Sweden, especially in the machine tool field. Hence, the value of production given is much less than the normal production of the shops, and does not in any way represent their capacity.

The machine tools built in Sweden are mainly for domestic consumption, although there is some export trade. The types built are therefore especially intended to meet the demands of the industries of the country, and for that reason sometimes differ considerably from the general types offered by American, British and German machine tool builders.

At the present time there is a severe depression in the machine tool industry partly on account of the keen competition with other countries, particularly Germany, and partly because the industries which are the main consumers of machine tools are also suffering from an industrial depression, and therefore are not in need of new equipment. It is believed, however, that when normal conditions again return, the Swedish machine tool industry will regain the position which it had formerly created for itself.

Development of the Machine Tool Industry

The making of machine tools in Sweden dates from about 1850. As in many other countries, it started with the building of machine tools in shops engaged in other machine-building activities. These shops produced the machines for their own use, merely to aid them in the manufacture of their product. Meanwhile the development of machine tools in England, America and Germany went forward with great rapidity and at the same time the Swedish industry grew so that the domestic demand for machine tools became more and more pronounced. At that time a number of the Swedish shops which in the past had been devoting themselves mainly to the manufacture of other products, began to specialize on machine tools, and gradually some of them gave their entire attention to this line of manufacture. In the following is given a brief outline of the development of some of the best known machine tool building shops in Sweden.

Leading Machine Tool Building Plants and their Products

Köpings Mechanical Works were founded in 1856, and began at an early date to engage almost exclusively in the building of machine tools, which at the present time constitute their sole product. This shop has created for itself a good reputation, and is known for careful workmanship, the use of first-class materials, and good designs. During the war, particularly, this firm maintained a considerable export trade. The shop owns its own foundry, and is known to use the most modern methods in both design and construction. Among the machines made are engine lathes from 16 to 44 inches swing, built with either cone-pulley or single-pulley drive, for both belt and direct-motor drive. Gap lathes in several sizes are also built, as well as turret lathes, wheel lathes, roll turning lathes, axle lathes, centering machines, open-side planers for large work, upright drilling machines, radial drills, horizontal drilling and boring machines, plain and universal milling machines, universal tool grinding machines, tool grinders, and foundry grinders. This company employs about 300 men, and the normal value of its production is about $800,000 annually.

Lidköpings Mechanical Works were started in 1874, and have gradually developed until they are now engaged entirely in the manufacture of machine tools. This concern also has a good reputation for first-class designs and workmanship. In this shop engine lathes up to 44 inches swing, with ranges similar to those mentioned for the Köpings Works are made, as well as gap lathes. This shop also specializes on lathes for ammunition making, and, in addition, builds open-side planers up to the largest standard dimensions, surface grinding machines and universal grinding machines. These shops have also made a specialty of building boring machines for big guns. The number of men employed is about 300, and the normal annual value of production, about $700,000.

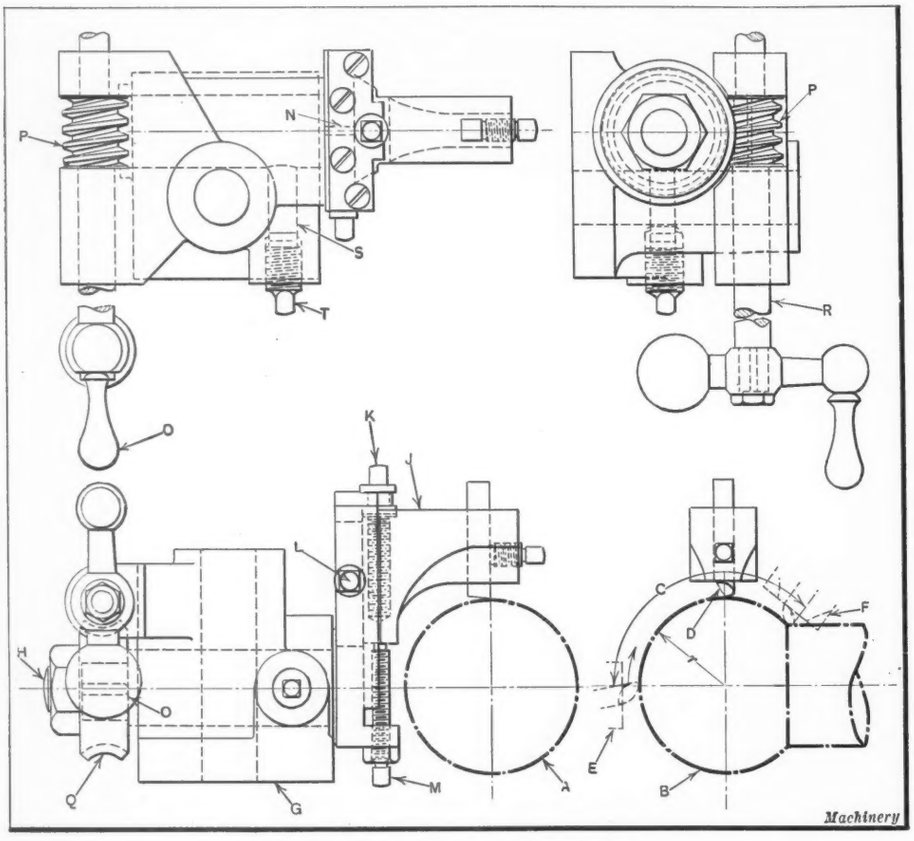
Enköpings Works were started in 1886, and have gradually specialized on machine tools, especially lathes, shapers, milling machines, drilling machines, grinding machines, and power hammers. This plant is also among those that are best known and has been able to work up an export trade. It employs about 400 men with an annual production value of about $550,000.

Munktells Mechanical Works, in Eskilstuna, while not building machine tools exclusively, have developed this branch so that during recent years one-third of the shop's production has been in the machine tool field. This shop builds engine lathes in practically the same ranges as the Köpings Works. It has also specialized in power presses, which are built in practically all modern construction and sizes, including double-acting power presses in weights up to 30 tons. Friction screw presses are also built. Another line manufactured by this company is drop-hammers, made in sizes up to 2600 pounds weight of drop, the whole machine weighing over 30 tons. This firm is also among the well-known builders in the machine tool field, and in times when industrial conditions permitted it, have conducted a considerable export trade. About 400 men are employed in the machine tool branch of the works, and the annual production is normally about $1,100,000. This firm operates the largest foundry in the Scandinavian countries. The works were originally started in 1832 and began building machine tools about 1850.

Among other machine tool plants in Sweden may be mentioned Thule in Malmö, started in 1908 and specializing on shapers, of which four sizes are built—14,- 16-, 20-, and 25-inch. This shop employs about 120 men, and produces normally about $275,000 worth of shapers a year. Gerhard Archns Mechanical Works in Stockholm are mainly devoted to the making of match-manufacturing machinery, but are also making milling, drilling and grinding machines. Their vertical milling machines especially have won a good reputation. Halldin & Co. in Orebro, started in 1868, have gradu-

ally specialized in the manufacture of power presses. Pytagoras Works in Norrtälje build mainly lathes. They employ about 100 men, and the manufacturing value of their product is about $275,000 annually. The Swedish Machine Works (Svenska Maskinverken) in Stockholm specialize in turret lathes, with a normal production capacity of over $500,000 a year.

The Atlas-Diesel Co. in Stockholm specializes in horizontal boring and drilling machines, upright drilling machines, pneumatic drills, milling machines (both of the vertical and horizontal type) as well as cylindrical grinding machines. The Arboga Mechanical Works in Arboga build forging presses. The Storebro Co. in Storebro, started in 1894, employs about 200 men, building lathes and milling machines with a normal annual production valued at about $275,000. Askersund Mechanical Works in Askersund build tool grinders and pneumatic and power hammers.



Ball-turning Attachment for Tool-room Lathe

Woodworking Machinery Industry

The building of woodworking machinery is highly developed in Sweden as a result of the great demand for machinery of this type in a country having a large saw-mill industry. Among the leading works devoted to this line of manufacture are Bolinders in Stockholm, Munktells in Eskilstuna, Askersund Works in Askersund, Falkenbergs Works in Falkenberg, Jonsereds Co. in Jonsered, and the Swedish Machine Works in Stockholm.

* * *

BALL-TURNING ATTACHMENT FOR LATHE

By F. H. SOVEREIGN

Various methods may be employed to machine spherical surfaces, but the size of the piece to be machined, its design, and the requirements as to quantity and accuracy are naturally determining factors in selecting the method to be used.* An attachment designed by the writer to handle the various classes of spherical turning work ordinarily met with in the tool-room is shown in the accompanying illustration. This attachment has a range of adjustment that meets the usual requirements for turning the spherical ends of ball-crank handles and similar tool-room work. If desired power feed can be applied to the attachment by connecting the end of worm-shaft *H* with the knuckle joint shaft of the lathe relieving attachment. The operation of the attachment will be readily understood by referring to the illustration.

The end view of the work to be machined (looking toward the lathe headstock) is represented by the heavy dot-and-dash circle at *A*. At the right of this view is indicated diagrammatically the path followed by the tool in turning or finishing the work to the spherical form indicated by the side view shown in heavy dot-and-dash lines at *B*. The arc through which tool *D* is required to move is represented by *C*. The radius *r*, or distance of the cutting tool from the center of the work, determines the diameter of the turned ball. The extreme positions of the tool are clearly indicated by means of the dotted lines at *E* and *F*.

Base *G* of the attachment is a casting mounted on the compound rest of the lathe. In attaching base *G* to the compound rest, care is taken to see that shaft *H* is set at right angles to the lathe spindle. On the inner end of shaft *H* is a rectangular section with a dovetail groove in it in which the dovetail tongue of the tool-slide *J* is fitted. The tool *D* is positioned for turning spherical work to the required diameter by adjusting slide *J* by means of screw *K*. When properly adjusted to the required radius *r*, slide *J* is locked in place by screws *L* and *M*. It should be noted that a slot *N* is cut at the back of the dovetail groove to permit screw *L* to exert the required clamping action on the dovetail tongue of slide *J*.

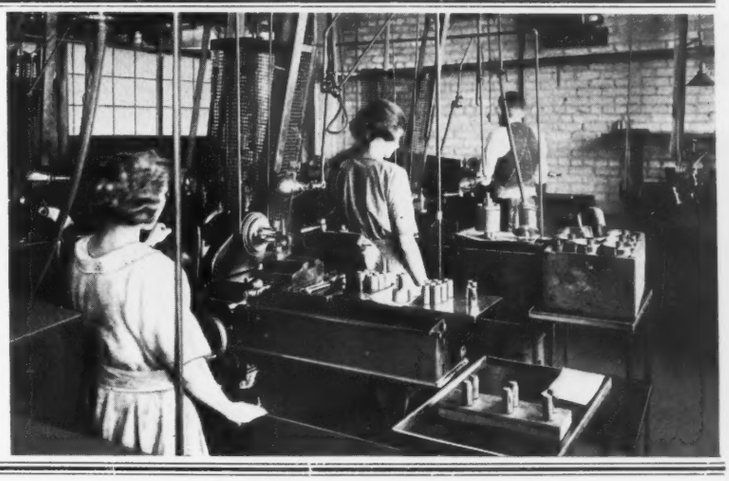
In operation, the tool is moved through arc *C*, or whatever part of a circle is necessary to produce the required form, by means of ball-crank handle *O*, worm *P*, and worm-wheel *Q*. Worm *P* is keyed to shaft *R*, while worm-wheel *Q* is keyed to shaft *H*. A friction block *S* is provided, which can be adjusted by screw *T* so that just the right pressure will be exerted on spindle *H* to insure smooth operation of the tool, or it can be adjusted to lock the spindle in a fixed position.

The more important dimensions of the various details entering into the construction of the attachment shown are: Height of shaft *H* above bottom of base, 1 19/32 inches; diameter of shaft *H*, 1¼ inches; maximum width of the tool-slide dovetail, 1⅞ inches; and length of tool-slide dovetail, 2¼ inches. The worm *P* has a right-hand single thread that is cut to fit the 12 diametral pitch teeth of worm-wheel *Q*. Worm-wheel *Q* has 24 teeth and consequently a pitch diameter of 2 inches. The maximum diameter of work accommodated by this attachment is about 3 inches. The dimensions given are those employed in the design illustrated, but these dimensions could easily be varied to meet special requirements. In order to insure accuracy, the hole for shaft *H* should be bored to size with the casting mounted on the compound rest of the lathe on which it is to be used.

*Spherical turning attachments for different types of machine tools and the methods of their application are described in Volume 5 of MACHINERY'S Encyclopedia beginning on page 444.

Diamond Tools as Cost Reducers

Use of Diamonds for Cutting Various Materials—Preparation of the Diamond—Economies Introduced by the Application of Diamonds as Manufacturing Tools—Multiple-stone Diamond Dresser for Emery Wheels



ONE of the most common industrial uses of diamonds is for drawing dies for fine gages of wire. A complete description of the preparation, setting, and refinishing of diamond wire-drawing dies was published in MACHINERY, November, 1919, page 264. Other common commercial applications of the diamond are found in the cutting of stone, cement, glass, porcelain and similar hard substances, but the introduction of diamonds in place of hardened steel tools for machining operations is comparatively recent.

The variety of work for which the diamond cutting tool is suitable is not appreciated by manufacturers. If the use of diamonds as emery wheel dressers be excepted, there is no application of diamonds as cutting tools in the average machine shop. There remains, therefore, much to be said which should interest both the mechanic and the manufacturer—particularly the manufacturer, because he is vitally interested in the problem of reducing production costs. If he can be convinced that by substituting a diamond cutting tool for a steel one he can considerably reduce his operating expenses, he will soon appreciate the economies which diamond tools make possible.

For machining bronze, brass, and similar metals which are not brittle, and for performing various machining operations on hard rubber, fiber, compressed paper pulleys and gear blanks, strawboard, gutta-percha, bakelite and various other composite substances now in commercial use, the diamond is especially suitable on account of its ability to retain its cutting edge when producing great quantities of duplicate parts without frequent attention or resetting.

Work which has a uniform diameter over a considerable length, such as the brass sliding tubes of a telescope or hard rubber typewriter rolls, is successfully turned by the use of diamonds and without the slightest perceptible variation in diameter occurring in tens of thousands of parts. Diamond tools may also eliminate some operations which must be performed when a steel tool is used for finishing. The surface produced on brass and bronze is comparable to a fine lapped finish and therefore eliminates the necessity of reaming, finish-boring, grinding, or lapping to obtain the desired surface. It will be seen that the variety of work to which the diamond tool can be applied is very extensive. Its use for machining iron and steel is not practical, however, as these metals are likely to cause the brittle diamond to crack or chip.

Bortz, or "white" diamonds, brazed into steel holders, have many uses as metal finishing tools. They are employed for numerous machining operations that formerly were performed with steel tools. This article gives a brief description of the preparation of diamonds for commercial use, indicates how they are set in the holders, and furnishes information regarding their cost. An approved method of setting diamonds in wheel dressers, as well as in a number of metal-cutting tools is described, together with the kind of work for which each tool is suitable. The article concludes with a few examples showing the application of diamond tools in a number of plants.

Preparation of the Diamond for Setting in a Tool

The process of setting a diamond in a tool is simple to describe, but requires great skill on the part of the man who performs the delicate work. The most common type used for industrial purposes is the bortz diamond (see Fig. 1) which is found in the same mines of South Africa as those from which sparkling gems are obtained. Bortz diamonds (sometimes called crystal diamonds) are unsuitable for jewelry owing to their color, impurities and structure. Furthermore, they are difficult to cut. The black diamond or "carbon," as it is called in the vernacular of the diamond trade, is found only in Brazil. The best specimens are as hard and durable as bortz. Owing to its porous structure, its cutting edge is more suitable for a roughing cut than for a finishing cut. Bortz diamonds have a laminated structure, the boundry of each layer of which is known as a "cleavage plane."

The diamond worker studies the stone carefully before determining the location of these cleavage planes, and then proceeds to cleave the diamond or split it "along the grain." It is common knowledge that nothing but a diamond or diamond dust will cut another diamond. In cleaving one of these precious stones, the surface is first cut to a certain depth preparatory to splitting, by means of a special machine having a thin copper disk charged with diamond dust. When the proper depth of cut is reached, the stone is cleaved by giving it a sharp blow along the seam. All this is part of a very expert trade. It is stated that an experienced man can cleave any stone—with few exceptions—exactly as he plans.

All subsequent sawing, cutting holes and shaping that is required to form the stone properly for any particular

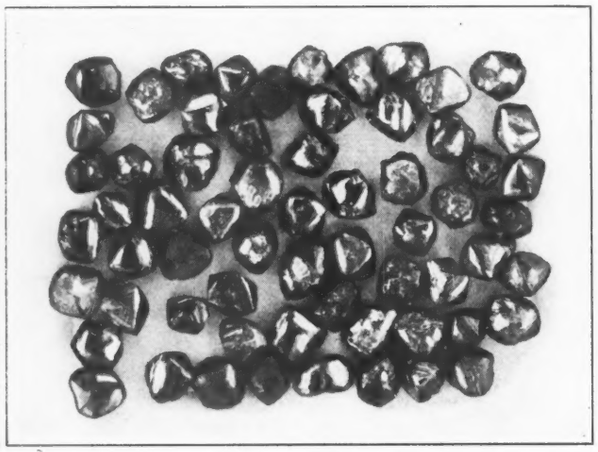


Fig. 1. Collection of Rough Bortz Diamonds

service as a cutting tool, is done by lapping the diamond with power-driven tools charged with diamond dust, or by hand using another diamond of suitable size and shape. The largest diamonds used for industrial purposes are not much more than 20 carats, and the smallest size stone which can be used in a cutting tool is ⅛ carat. (A carat is equivalent to about 3 1/6 grains Troy.) It is advisable to use a diamond of the largest possible size that is suitable for the work at hand, as this permits the diamond to be reworked and reset if necessary; also a large diamond has a greater percentage of salvage value than a small diamond, thus making the net cost much less. The comparative costs per carat of diamonds of different sizes will be taken up in a later paragraph.

Types and Characteristics of Settings

The next step after cutting and shaping the diamond to its approximate form and producing the cutting edge is to set it securely in a steel holder. The setting of the diamond is of vital importance to the strength and serviceability of the tool. There are two styles of settings—the steel setting in which the diamond is partially fitted into a hole in the end of the holder and the metal peened over it to hold it in place, and the brazed setting in which the stone is held securely in the hole by molten speiter. An example of each of these types, cut away to show the position which the diamond occupies in the setting, is illustrated in Fig. 2. The brazed setting, shown in tool *O* is more satisfactory for all classes of work and particularly for hard, tough materials on account of the yielding nature of the diamond pocket which offers a less rigid resistance to the material while the tool is taking the cut than in the case with the steel setting.

Overheating a diamond, no matter how it is set, is responsible for more trouble with diamond tools than any other cause. The idea seems to be common among workmen that as a diamond is hard, it will stand almost any pressure and frictional heat; this is true of the diamond itself, but the setting is affected to the extent of loosening its hold on the stone, causing the latter to drop out of its pocket.

The coefficient of expansion of a diamond is less than of steel, but when the diamond is heated by the cutting action, it expands before the heat penetrates to the steel to a degree which will cause the steel to expand. The increased volume of the diamond must go somewhere. The diamond is naturally brittle and has a laminated structure. The heat weakens this structure, causing the confined stone to crack along the lines of cleavage, due to the pressure caused by its confined position; or the diamond literally creeps out of the steel setting. A frequent repetition of this causes the stone to loosen sufficiently to fall out. The brazed setting is better in that it allows for the expansion of the diamond without causing the setting to be disturbed perceptibly, provided, of course, that the diamond is not excessively heated.

Characteristics and Cost of Diamonds

A diamond is crystallized carbon and is the hardest known substance. It will stand a white heat without disintegration or visibly affecting its wearing qualities. Men who use emery wheel dressers may have noticed the phenomenon of a diamond becoming white-hot when truing a wheel, even while a stream of cold water is impinging on the stone. This unusual characteristic of the diamond to retain its hardness after being excessively heated is further illustrated by an experiment which was recently conducted in the shops of Arthur A. Crafts & Co., 125 Summer St., Boston, Mass., where much of the data here presented was obtained. This experiment consisted of heating a diamond cutting stone to a white heat and quenching it in cold water

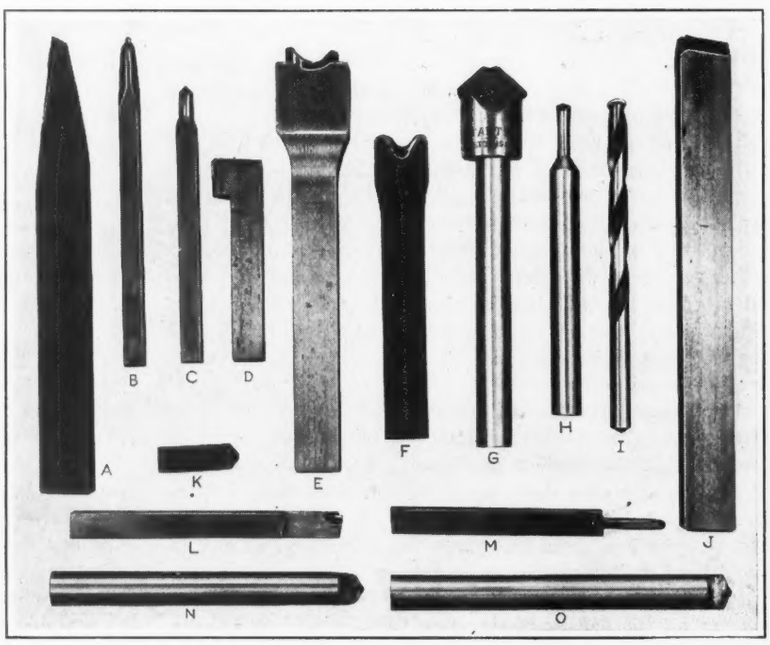


Fig. 2. Types of Diamond Cutting Tools

and repeating this performance one hundred times. The tool carrying this diamond was then shipped to a customer. After having been in service for several weeks, truing grinding wheels, it was found to be in no different condition, apparently, than when new, and entirely unaffected by the severe treatment to which it had been subjected.

One of the first questions likely to be raised regarding the use of diamonds for reducing manufacturing costs would be in regard to the initial cost of the diamond itself. It is true that the first cost of a diamond tool is comparatively high, but this is practically the only expense involved, which makes it plainly evident that the larger the quantity of work machined the greater the saving in tool expense. Diamonds vary in value per carat according to the size of the stone. A large stone weighing, say, 20 carats, if of good even grain, may be worth as much as $80 a carat, but this same stone automatically diminishes in value per carat as the stone is divided or cleaved into smaller pieces so that stones weighing 5 or 6 carats, taken from the same original diamond, will shrink in value to about $45 per carat. Smaller diamonds weighing, perhaps, 1 carat decrease in value to about $5.

From the foregoing it will be understood that much care in the preparation of the stones is required on the part of the diamond worker, for otherwise a great deal of diamond chips and dust would result which means an additional expense. Incidentally, it may be mentioned that all chips which are too small to be set are pulverized by means of a pestle and mortar and the dust thus obtained graded by floating in olive oil. The dust is then utilized to charge the cutting surfaces of the metal tools used in shaping the diamonds.

Multiple-stone Diamond Dresser for Emery Wheel

In referring to comparative costs of diamonds with respect to their size and usefulness for a particular service, attention is called to the two emery wheel dressers shown in Fig. 4. The multiple-stone type, carrying four small diamonds, brought out by Arthur A. Crafts & Co., has been used with satisfaction by several machine builders and tool manufacturers, and has proved its economy over the single-stone dresser of large size.

The multiple tool contains four diamonds of the best grade, the total weight of which is about 2½ carats. The price of the tool is $30. The single-stone dresser has a 2½ carat diamond of the best grade, but owing to its greater size this diamond is worth $75. With the multiple tool the wear is divided among four points so that the advantage of a sharp tool is maintained longer than can be possible with a single stone. In addition there is less pressure per stone and less heat generated; also the larger cooling area of the holder helps to maintain the secure setting of the diamonds. After the diamonds have been worn down to ⅛ carat, they can no longer be reset and they have a salvage value of about 50 cents each, so that the net cost of the tool is $28.

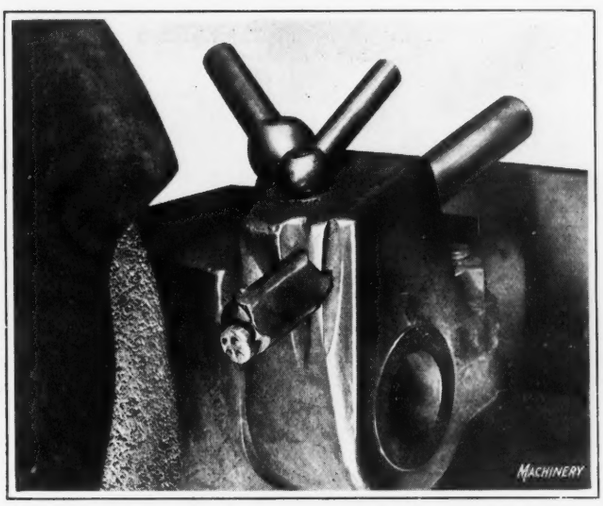


Fig. 3. Four-stone Diamond Wheel Dresser set up for truing a Grinding Wheel

The single-point tool, in order to perform the same amount of work as the multiple tool, will wear down to a broad flat surface much quicker than will the smaller diamonds; also more heat may be generated which is likely to result in loosening the setting after repeated use. As a result, more frequent resetting is required which adds to the net cost of the tool. When the diamond becomes worn so that it is too small to be reset it has about the same salvage value as the other diamonds. The net cost then, is $74.50.

The application of the four-stone dresser is shown in Fig. 3 in which it will be seen that it is located in the holder with the diamonds set square with the face of the wheel. In traversing the diamonds back and forth over the face of the emery wheel, the two leading stones, one upper and one lower, take most of the cut and the second pair which follows directly behind, removes the slight irregularities remaining on the face of the wheel. The same total depth of cut is taken as would be used with a single diamond tool. It might at first be thought that the small stones which first traverse the wheel would remove so much of the bonded abrasive that they would become unduly worn and overheated and thus eventually throw the bulk of the service on the rear pair; but both the bearings and the bonded wheel itself yield sufficiently under the pressure of the first two diamond points so that when the two rear diamonds are brought into use they remove practically the same amount of abrasive from the face of the wheel as do the leading stones. Any wear which occurs on the leading stones permits the following pair to start cutting, and all four must give service before the tool is used up.

Obtaining the Best Results with Diamonds

Practically the only uses to which diamond tools can be commercially adapted for cutting steel is in the scribing of sizes, names and other identification marks on the finished surfaces of such products as scales, micrometers and various other tools and gages. In fact, one well-known tool manufacturer makes use of a diamond tool for inscribing the sizes on their standard line of hardened limit gages. The tools used on this class of work are carried in the revolving spindle of a profiling machine. The depth of cut is about 0.010 inch.

Diamonds should not be expected to give good results where there is any serious vibration of the work. In short, any condition which makes the tool chatter is undesirable, particularly if the material being machined is very tough or if it is high in tensile strength. High rotative speeds for the work are recommended, say 200 surface feet per minute for all types of tools. A slow feed should be used in combination with the high rotative speed.

The tools shown at *A* and *J*, Fig. 2, are ordinary turning tools with different types of diamond settings. The cutting edge of tool *A* is a diamond over ⅜ inch long. Either of these two tools would be suitable for turning the compressed paper pulley shown at *G*, Fig. 5 or the fabroil gear blank *I*. Tool *D*, Fig. 2, was used for facing the molded bakelite timer shown at *C*, Fig. 5, as well as the ends of the copper inserts which are assembled in the timer. It will be noticed that the diamond is not rounded at the corner but that it is cut with a straight angular face at the nose of the tool. This is a special precaution taken to eliminate a difficulty formerly encountered with the use of a round-nosed tool. The chips produced in facing the inside of this timer, when a rounded diamond was used, were comparatively wide at the upper part and tapered down to a thin edge near the point of tangency of the tool with the surface being produced by the facing operation. This thin wedge-like chip would break near the lower part of the rounded portion of the diamond and cause the tool to become dull. By squaring off this rounded corner an even chip was produced which did not have the destructive effect experienced with the rounded stone.

Other Types of Diamond Tools

Tools *E* and *F*, Fig. 2, are used for forming fiber flanges on the wooden spool *H*, Fig. 5. Tool *E* is an improvement over tool *F* in that there are two diamonds mounted separ-

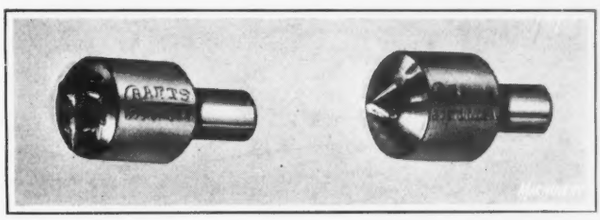


Fig. 4. Single- and Multiple-diamond Wheel Dressers

ately in it instead of one. This provision allows for variation in wear without increasing the thickness of the flange or its curvature, it being only necessary to shift the tool the proper amount from right to left, in order to round opposite sides of a flange or disk-like part. It will also be appreciated that the cost of a tool of this kind is comparatively less than where one large diamond is used valued at considerably more per carat. Not only is a greater first cost involved in using a single-diamond tool, but the resharpening of a tool of this type is more expensive.

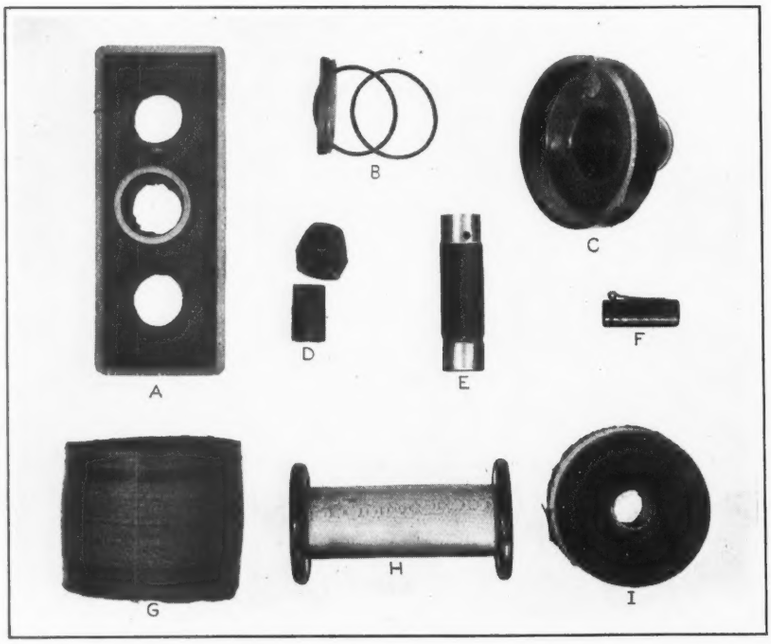


Fig. 5. Articles made from Tough Non-metallic Materials for the Manufacture of which Diamond Tools are used

A rather unusual design of diamond cutting tool is shown at *G* in the collection of tools. There are two full-length diamond lips each about ½ inch long set in this countersink, which is used for countersinking holes in hard rubber, or other tough substances, for the accommodation of screw-heads. Tool *H* is a glass drill carrying a two-lipped diamond. The twist drill *I* is mounted with a thin diamond, a natural flat crystal. Added strength and wearing qualities are furnished a stone if it can be used without removing the original surface. The lips of the diamond are formed with cutting edges having suitable clearance angles as in an ordinary twist drill, and the diamond is set into the web between the lips by brazing.

The tools *L* and *M* are used either for grooving or as cutting-off tools. Tool *L* has square corners as would be required for cutting a square groove and the view enables the brazed setting of the diamond to be observed. Tool *M* has a rounded cutting edge formed on the diamond, as would be required for forming a groove of circular section. At *K* is illustrated the end of a diamond tool which has been employed for a long period of time; the curved depression in the steel above the diamond has been worn away by the flow of chips. In order to produce as much wear as this tool has been subjected to, simply by the friction of chips, the diamond must have been in service many times longer than it would be possible for a steel tool to endure. In fact, it has often been found that the cause for resetting a diamond is not due to any deterioration of the diamond itself but to the action of chips wearing away the steel which supports it.

The other parts shown in Fig. 5 and not mentioned in connection with the collection of tools, are the hard rubber cover shown at *A* in which two end holes are bored; the screw plug *D* also made of hard rubber on which threads are cut; fiber connection *E*, the ends of which are turned; the celluloid rings *B* used for eyeglass rims; and the hard rubber fountain pen top *F* which is bored, beveled, and rounded in the closed end with diamond tools, used in screw machines.

Examples Illustrating Application of Diamond Tools

The use of diamonds for turning long cylindrical parts which must have a uniform diameter throughout has previously been referred to and one instance of this application is that of turning the brass sliding tubes of telescopes and field glasses, this use of diamonds being made by the Bausch & Lomb Optical Co., Rochester, N. Y. These tubes are often several feet in length and present a condition which by the use of steel turning tools caused considerable trouble in maintaining a uniform diameter throughout.

Another common use of diamonds for turning tough materials of long cylindrical shape is found in the manufacture of hard rubber typewriter rolls. Diamonds are also extensively used in the various turning and boring operations performed in the manufacture of hard rubber fountain pens, and it is stated that a single turning tool will give accurate results on this kind of work for months, turning out hundreds of thousands of these parts without affecting the cutting edge of the tool or without need of resetting the stones.

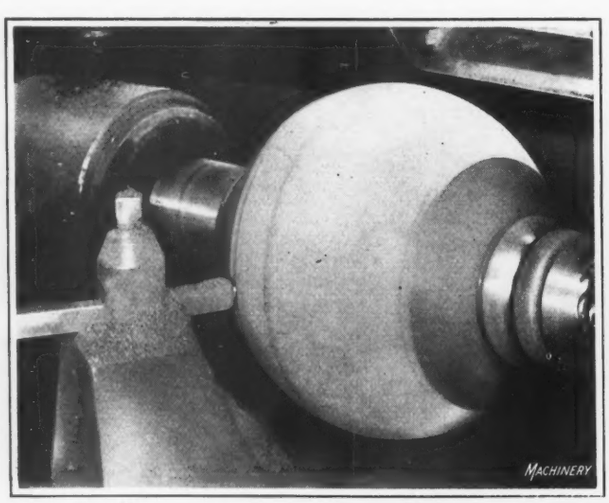


Fig. 6. Lathe set up with Diamond Tool for turning a Bowling Ball

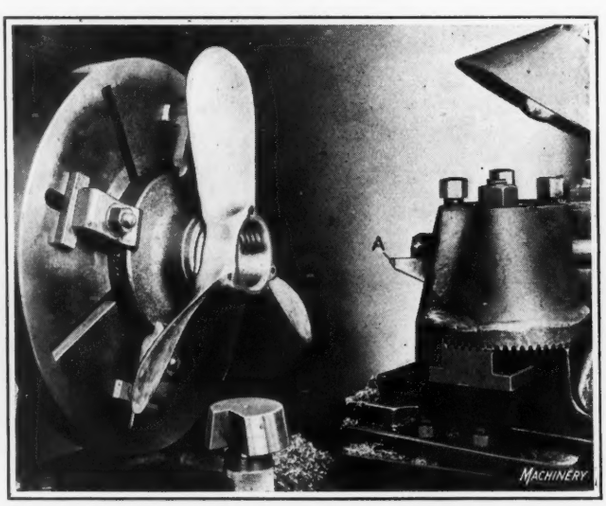


Fig. 7. Taper-boring a Bronze Bushing in a Fan with a Diamond Tool

Bowling balls and similar spherical articles made from gutta-percha, fiber or some form of molded composition are turned with diamond tools. Such a use of diamonds is illustrated in Fig. 6 in which a set-up used for turning a bowling ball is shown. This lathe is equipped with special cupped head- and tail-centers, the diamond tool being located in the tool-post in the regular manner.

In the manufacture of aluminum fans for automobile engines, the Taft-Peirce Mfg. Co., Woonsocket, R. I., uses diamond boring tools for finishing the interior of taper bronze bushings with which these fans are furnished. This method of finishing was resorted to after other methods had proved inefficient. The work is now being finished without need of any subsequent operations to produce the desired degree of finish. Formerly an attempt was made to grind these bronze bushings, but the trouble experienced in charging the surface with abrasive resulted in this method being discontinued. The result obtained by the use of the diamond tool is comparable to that obtained by broaching or by burnishing or lapping; in addition, uniform results are obtained with one tool, for an indefinite length of time.

The fan is located on a special plate which is attached to the faceplate of a Lodge & Shipley lathe and the fan is secured against this plate by a large headed bolt which seats against the inner counterbored shoulder. The arrangement is illustrated in Fig. 7 which shows the diamond itself at *A*. The cutting speed is 180 feet per minute, and a very slow feed is employed. The time required to finish-turn this bushing including chucking the work, is 10 minutes.

A new field for diamond tools has been found in the manufacture of radio apparatus. Many of the parts used in radio instruments can be machined to advantage with diamond tools. It is reasonable to expect that diamond tools will be more and more widely applied when manufacturers become more familiar with their usefulness.

* * *

THE OBJECT OF COST KEEPING

The cost-keeping records of a manufacturing firm should aid in (1) determining the selling price of completed parts or machines; (2) determining the price of repair parts; (3) determining whether a part or device should be made in the shop or produced outside; (4) determining upon the value of newly proposed manufacturing methods, by comparing data of past performances with new records; (5) furnishing such statistics as may be of value in economically managing the plant—for instance, scrap costs, comparative costs of similar parts or units, and cost due to breakdowns. It is considered a good plan to have the cost records show the length of time consumed when the operation has been performed under both the day and piece-work system of payment. In starting a cost system, the uses of every figure collected should be ascertained; otherwise the system will deteriorate into red tape, and cost more than it is worth.

* * *

VALUE OF MACHINE TOOLS AND METAL-WORKING MACHINERY EXPORTED TO FRANCE, 1912-1921

Year*	Lathes	Sharpening and Grinding Machines	Other Machine Tools	Total of Machine Tools	All Other Metal-working Machinery	Total of Machine Tools and Metal-working Machinery
1912	.....	.....	.....	.....	.....	$1,267,831
1913	.....	.....	.....	.....	.....	1,936,908
1914	.....	.....	.....	.....	.....	1,771,525
1915	.....	.....	.....	.....	.....	8,695,826
1916	.....	.....	.....	.....	.....	13,316,702
1917	.....	.....	.....	.....	.....	29,254,379
1918	$5,873,301	$2,874,676	$2,620,350	$11,368,327	$8,902,203	20,270,530
1919	1,744,254	1,390,159	2,989,457	6,123,870	9,661,410	15,785,280
1920	912,345	520,932	2,405,836	3,839,113	3,756,620	7,595,733
1921	556,265	127,140	715,879	1,399,284	2,645,077	4,044,361

Machinery

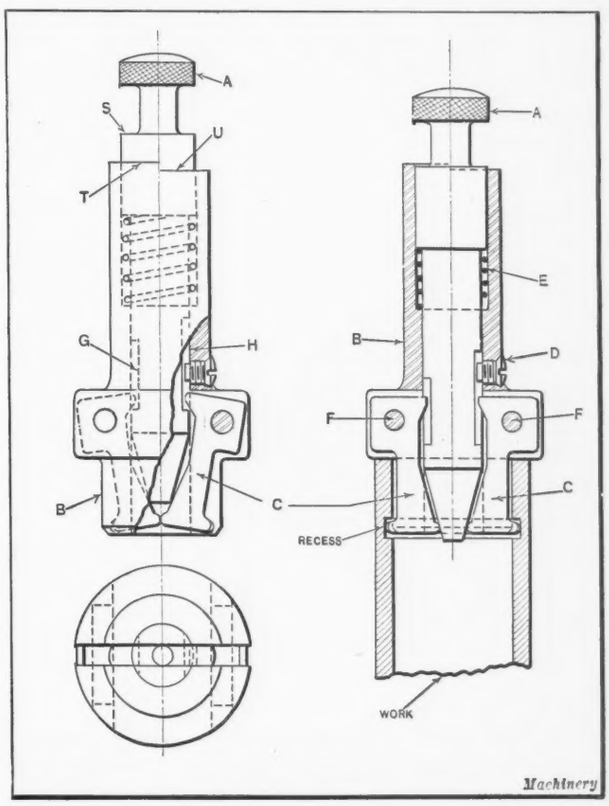
*Amounts given are for fiscal years up to and including 1918, and for calendar years thereafter. The Department of Commerce statistics did not give machine tool exports separately previous to 1918.

GAGE FOR TESTING DEPTH OF RECESS

By J. T. LONGDON

The illustration shows a limit gage of strong and simple construction that the writer designed for gaging the depth of the recess in small tubes. In use, the body *B* is inserted into the work as far as the shoulder will allow, and the plunger *A* is pressed down until stopped by the action of the gaging pieces *C* coming in contact with the bottom of the recess in the work. The relative positions of plunger *A* and the pieces *C* when in the gaging position are shown in the view at the right. When plunger *A* is pushed down, the gaging pieces are revolved on pins *F* so that their lower ends are forced outward into the recess to be gaged. When the shoulder *S* on plunger *A* coincides with the top step *T* on the body *B*, the gaging pieces *C* will be set to measure the minimum diameter of the recess in the work, and when the shoulder *S* coincides with the bottom step *U*, the gage will be set to measure the maximum diameter of the recess.

Referring to the left view, flats *G* and *H* are cut in plunger *A*. The flats provide clearance for the upper ends of pieces



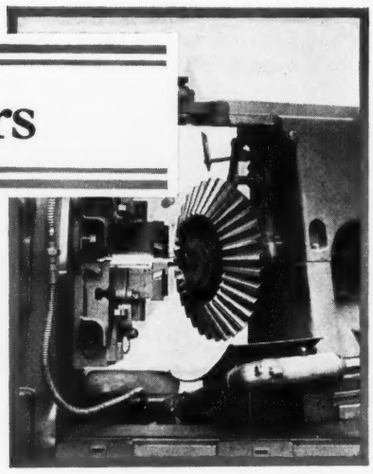
Limit Gage for testing Depth of Recess

C, and form shoulders which on the return stroke of plunger *A* engage with pieces *C*, causing them to swivel inward, thus withdrawing their measuring points from the work. The gaging pieces are protected when not in use, and a spring *E* actuates plunger *A* on its upward stroke. A set-screw *D* prevents plunger *A* from rotating. The height of the step on body *B* is governed by the number of degrees in the included angle of the conical section of plunger *A* and the amount of tolerance allowed on the work. When the tolerance is small, the number of degrees in the included angle of the conical section of plunger *A* should be equally small to give a step on body *B* high enough to permit easy reading.

* * *

The importation of machinery into Mexico is three times greater than it was ten years ago. From 1909 to 1921 over $122,000,000 worth of machinery of all kinds was bought by Mexico, and in 1921 alone the total value of machinery imported was $34,000,000.

Cutting Bevel Gears



Generating the Teeth of Large Bevel Gears—Formulas for Checking Chordal Thickness of Bevel Gear Teeth—Last Installment of a Series of Three Articles

By FRANKLIN D. JONES

ALTHOUGH the generating type of bevel gear planer is the kind used for finishing the teeth of small bevel gears, especially when accuracy is essential, large gears of coarse pitch are usually cut on a templet type of planer. In fact, the generating type of machine capable of cutting fairly large gears of coarse pitch, is comparatively recent. The templet type of machine is used invariably for very large gears, but Gleason generators are now made for cutting bevel gears which formerly were beyond the capacity of a generating type of machine. The Gleason generator shown in Fig. 1 will generate teeth of one diametral pitch, and has a capacity for pitch diameters up to 25 inches for miter gears. This machine operates on the same fundamental principle as the Gleason generator previously described, although the design is entirely different. It has two cutting tools like the older designs of generators, and these tools operate on both sides of the tooth which is finished before indexing to the next tooth. The head carrying the work-spindle is adjusted about a vertical axis, in accordance with the angle of the gear to be cut, and the tool-slides are also given an angular adjustment in a vertical plane to provide for the converging form of the teeth. The number of cutting strokes per minute is regulated by change-gears and the stroke length by a slotted crank as on the other machines.

When it is considered desirable to take both stocking and finishing cuts without removing the gear from the machine, this may be done readily. Stepped tools are used for the stocking cuts, and the generating motion is not utilized. This change for either roughing or finishing cuts can be made quickly. Fig. 2, which is a rear view, shows a planer taking stocking cuts.

How the Generating Motion is Derived

The tool-slides are carried by a drum-shaped member which has a bearing in the main column of the machine. When the planer is operating, this drum has a rolling motion acting in conjunction with a rolling movement imparted to the gear being cut. This generating motion is obtained by connecting the tool-carrying drum with the work-spindle through a suitable combination of gearing. The resulting motion is the same as that obtained from rocking crown and master gear segments together, as described in connection with the other generators, but compound change-gears are used in this large machine, and the extent of the rolling motion is controlled by a reversing mechanism. A graduated scale enables the operator to check the extent of the rolling motion, as determined for the particular gear being cut.

Testing the Thickness of a Bevel Gear Tooth

When setting up a machine for finishing the teeth of bevel gears, it is essential to cut the teeth so that the thickness along the pitch circle is equal to one-half the circular pitch, minus whatever slight amount may be allowed to provide clearance for the teeth of a mating gear. The backlash adopted by the American Gear Manufacturers' Association for different diametral pitches and for diameters from 3 to 20 inches, is as follows: 2 pitch, backlash 0.012 to 0.015 inch; 3 pitch, 0.10 to 0.012 inch; 4 pitch, 0.008 to 0.010 inch; 5 pitch, 0.008 to 0.009 inch; 6 pitch, 0.006 to 0.008 inch; 8 pitch, 0.006 to 0.007 inch.

When the first tooth is finished, its thickness at the pitch line is tested either by using a solid or non-adjustable gage made to suit whatever pitch is being cut, or by using a vernier gear tooth caliper, which is a graduated measuring tool applicable to any pitch within its range. The gage or caliper is applied to the large end of the tooth and is held approximately in alignment with the end surfaces or back cone when testing the tooth thickness. The distance between the measuring points equals the chordal thickness of the tooth. As the chordal thickness of gear teeth of the same pitch varies for different numbers of teeth, a solid or non-adjustable gage can only be absolutely correct for one number, but the use of solid gages is common, as they are considered sufficiently accurate for practical purposes; moreover, solid gages are preferable to a vernier caliper as a shop tool because the vernier caliper must be adjusted and there is always a chance of error when taking the reading.

Formula for Chordal Thickness and Corrected Pitch Depth

When the chordal thickness must be calculated, this can be done by using the same formula as for spur gears, assuming that the bevel gear teeth are of standard proportions. If N = number of teeth; T = chordal thickness of pitch line; D = pitch diameter, then

$$T = D \times \sin \frac{90 \text{ degrees}}{N} \qquad (1)$$

When the gage or caliper rests upon the top of a tooth, the lower ends of the jaws must contact with the sides of the tooth, at the point where the chordal thickness was determined; that is, at the pitch line when using the formula just given. If a vernier gear tooth caliper is used, the horizontal scale is set to the chordal thickness T, and the vertical scale to a dimension known as the corrected pitch depth or corrected addendum. The value of H may be determined by the following formula, in which S = pitch depth or addendum; R = pitch radius; N = number of teeth; and a = pitch cone angle:

$$H = S + \cos a \left(R - R \cos \frac{90}{N} \right) \qquad (2)$$

This is unlike the formula used for spur gears, as it is necessary to allow for the fact that a bevel gear tooth is

measured at an angle to the plane containing the pitch circle.

Formulas based upon the back cone distance B have been widely used for determining the chordal thickness and corrected pitch depth of bevel gears, but the same results are obtained with the comparatively simple formulas given in the foregoing.

Example—Find the chordal thickness and corrected pitch depth of a pinion having 20 teeth of 1 diametral pitch, and a pitch cone angle of 26 degrees 34 minutes.

The pitch diameter $= 20 \div 1 = 20$ inches.

$$T = 20 \times \sin \frac{90 \text{ deg.}}{20} = 20 \times 0.07846 = 1.569 \text{ inches}$$

The addendum for 1 diametral pitch equals 1 and

$$H = 1 + 0.89441\ (10 - 10 \times 0.99692) = 1 + 0.89441 \times 0.0308 = 1.028 \text{ inches}$$

Formulas for Teeth having Modified Pitch Depths

When cutting gearing having teeth of special pitch depths or thicknesses, the formulas previously given for finding the chordal thickness and corrected pitch depth, must be changed to allow for variations from the standard tooth proportions. The following formulas, which are applicable to bevel gears having either standard or special teeth, take care of any variation of tooth thickness, as when gearing with long and short addenda is used (for reasons that will be explained later). In these formulas, X is equal to the circular thickness of the tooth on the pitch circle; the notation otherwise is the same as that for the formulas which were previously given for standard teeth.

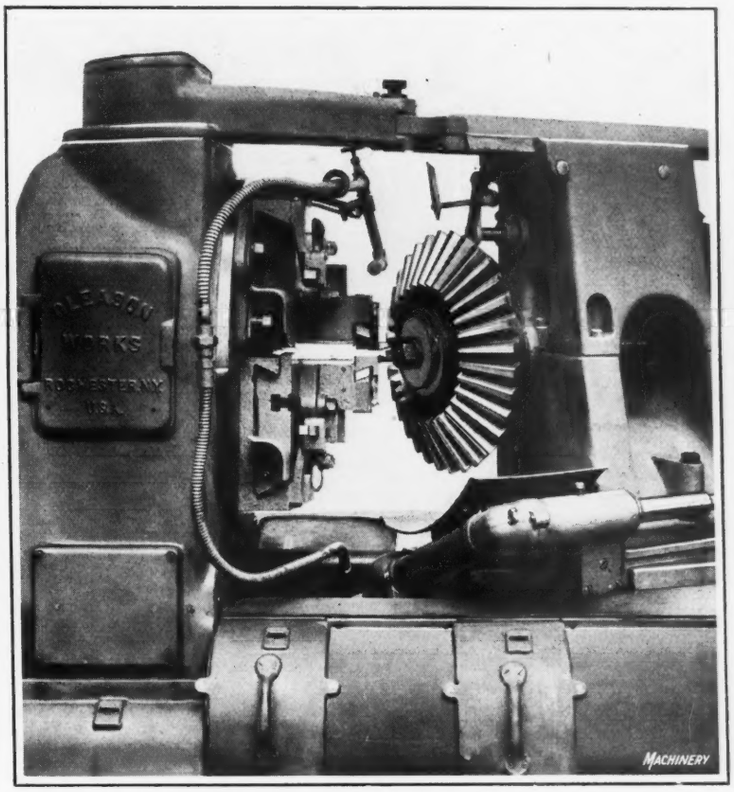


Fig. 1. Gleason 25-inch Bevel Gear Generator

$$T = D \times \sin \frac{90X}{R \times 3.1416} \qquad (3)$$

$$H = S + \cos\ a \left(R - R\ \cos \frac{90X}{R \times 3.1416} \right) \qquad (4)$$

Circular Thickness when Teeth have Modified Pitch Depths

If the addendum of a tooth is not standard or is not equal to 1 divided by the diametral pitch, the circular thickness at a given pitch depth may be determined as follows: First find the difference between the given pitch depth and the normal pitch depth, and multiply this difference by the tangent of the pressure angle of the gear; multiply the result thus obtained by 2, and then subtract the product from one-half the circular pitch for the gear; for the pinion, *add* the product to one-half the circular pitch. The final result equals the circular thickness corresponding to the given pitch depth.

If X = circular thickness of the *gear* teeth; x = circular thickness of the mating *pinion* teeth; D = difference between normal pitch depth and given pitch depth; P = circular pitch; B = pressure angle of gear, then

$$X = \frac{P}{2} - 2\ D \tan B \qquad (5)$$

$$x = \frac{P}{2} + 2\ D\ \tan\ B \qquad (6)$$

Calculations for Pinion having Special Pitch Depth

A pinion having 17 teeth is to run with a 60-tooth gear. The circular pitch is to be 0.6803 inch, and the pressure angle 14½ degrees. To avoid under-cutting, the pinion teeth are to have a pitch depth or addendum of 0.303 (instead of 0.2165, which is standard for this pitch) and the pitch depth of the gear is to be shortened to 0.130. Find the chordal thickness and corrected pitch depth for the pinion.

The pitch diameter is equal to 3.68117 inches. The circular thickness of the pinion teeth is next found. The difference between the normal and given pitch depths equals $0.303 - 0.2165 = 0.0865$. The tangent of the pressure angle of 14½ degrees = 0.25862. Inserting these values in the formula previously given for finding the circular thickness, we have

$$x = \frac{0.6803}{2} + 2 \times 0.0865 \times 0.25862 = 0.3848 \text{ inch}$$

$$T = 3.68117 \times \sin \frac{90 \times 0.3848}{1.84 \times 3.1416} = 3.68117 \times \sin 5\ 99 \text{ deg.} = 0.384 \text{ inch}$$

The corrected pitch depth is now obtained by means of formula (4) previously given. The cosine of the angle 5.99 degrees, just determined, is used in this formula, and also the modified pitch depth which is to be 0.303 inch. If the pitch cone angle of the pinion is not known, the tangent may be obtained by dividing the number of teeth in the pinion by the number of teeth in the gear. Thus $17 \div 60 = 0.2833$ = tangent 15 degrees 49 minutes.

$$H = 0.303 + 0.96214 \times \left(1.84 - 1.84 \times \cos \frac{90 \times 0.3848}{1.84 \times 3.1416}\right) = 0.303 + 0.96214 \times (1.84 - 1.8299) = 0.312 \text{ inch}$$

Changes of Pressure Angle and Tooth Proportions

As the pressure angle of the gear is the same as the angle of the cutting edges of the tools, gears of any pressure angle required may be cut readily on a generating type of machine. When the pressure angle is 14½ degrees (the angle commonly used outside of the automotive field) the minimum numbers of teeth on the pinion, recommended by the Gleason Works for different gear ratios, are as follows: Ratios from 6 to 1 down to and including 3 to 1 should have pinions with not less than 21 teeth; for a ratio of 2 to 1, 19 teeth; for 1½ to 1, 18 teeth; for 1 to 1, 14 teeth.

If smaller pinions are used, the flanks of the teeth will be under-cut, but this may be avoided either by increasing the pressure-angle or by lengthening the addendum of the pinion and shortening the addendum of the gear a corresponding amount. The usual practice for gearing of this kind is to make the addendum of the pinion 0.7 of the working depth, and the addendum of the gear 0.3 of the working depth. The circular thickness of teeth having these proportions may be found by multiplying the circular pitch by the following constants:

Pressure Angle	Gear	Pinion
14½ degrees	0.4341	0.5659
15 degrees	0.4317	0.5683
20 degrees	0.4073	0.5927

This is the last installment of the series of three articles on the cutting of bevel gears, which was begun in July MACHINERY.

* * *

PLANNING THE LOCATION OF MACHINE TOOLS

Any industrial plant should have a predetermined arrangement or lay-out of the equipment, if the maximum service is to be obtained from it when in operation. The equipment should be so located that the material will flow through the plant without serious interruptions from the receiving room to the shipping room. Furthermore, the machinery and the entire plant should be so arranged that it can be enlarged with a minimum shifting of equipment.

The simplest way in which to plan the arrangement of the machines in the shop is to use a drawing or blueprint of the floor plan of the building, drawn to a large scale, and to locate upon this drawing or blueprint small pieces of heavy drawing paper or cardboard representing the machines to be installed, cut out to the same scale. In this way the machines can be shifted around on the drawing until a satisfactory arrangement has been found. In placing the machines, sufficient space must be allowed for countershafts and lineshafts. In some plants it is customary also to indicate, by means of a string placed on the drawing, the general route that a part would have to take through the plant while being operated on. Pins may be placed in the drawing and the string stretched around them. This affords a very clear means of showing whether or not the path of the work through the shop is as straight as possible or whether too much moving and trucking of parts back and forth will be required.

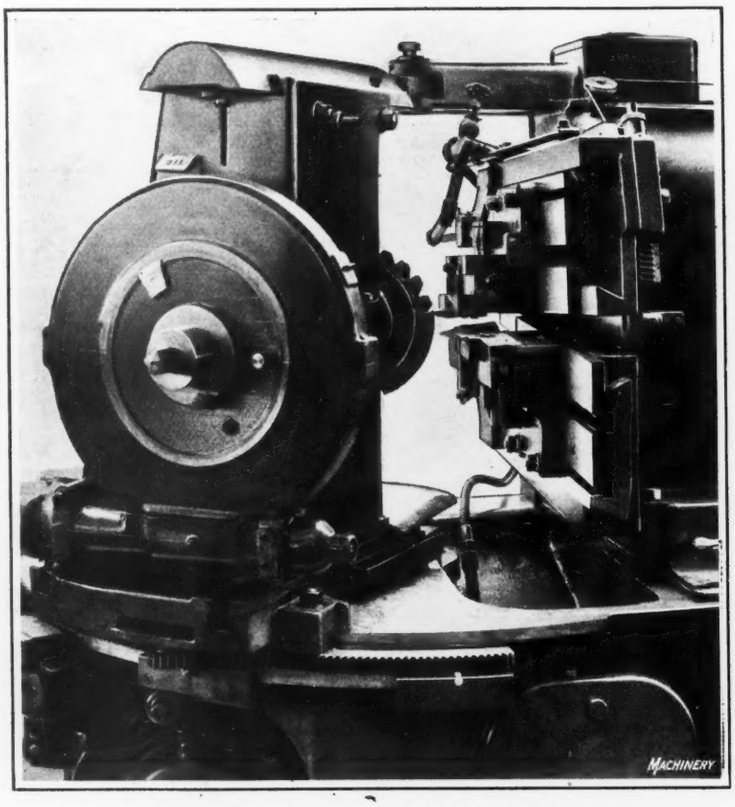


Fig. 2. Taking Roughing or Stocking Cuts on a 25-inch Generator

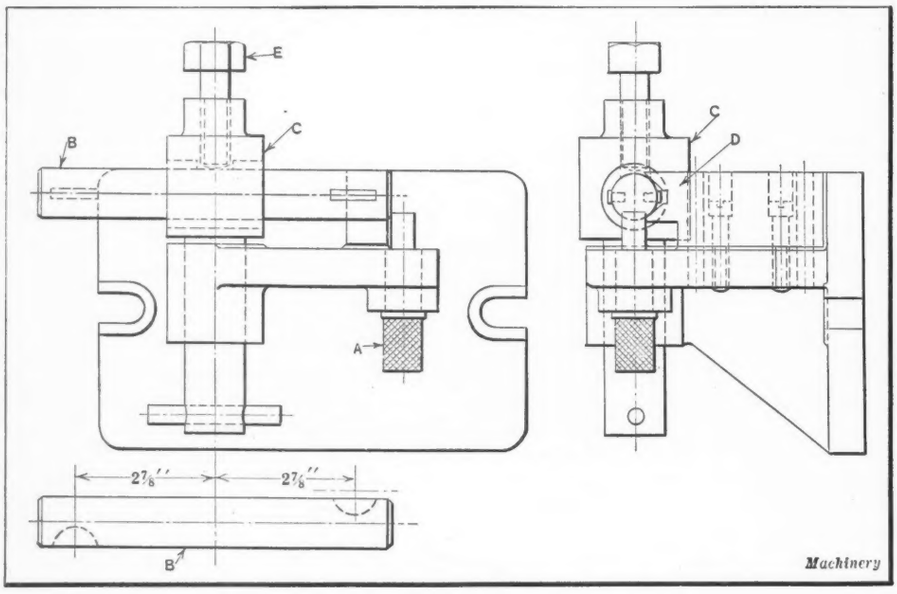
* * *

KEYWAY MILLING FIXTURE

By JOSEPH LANNEN

The fixture illustrated was designed for use in milling two Woodruff keyways located on opposite sides and on opposite ends of the clutch throw-out shaft of an automobile. The indexing arrangement which permits both keyways to be cut in one set-up on a hand milling machine is a noteworthy feature of this fixture. The pin *A* is inserted in the fixture in order to serve as a locating point for the work *B*, which is held in a trunnion *C* at a point equidistant between the keyways that are to be cut. The trunnion has a bearing in the body of the fixture which permits it to turn as well as to slide transversely with regard to the axis of the work. This permits the work to clear the V-block *D* when being indexed.

In operation, the work is clamped in the trunnion *C* by the set-screw *E*, being centered by the V-block *D* and located endwise by the locating pin *A*. The first keyway is then cut, after which the locating pin is withdrawn and the work indexed 180 degrees. The opposite end of the shaft is then placed in the V-block and the second keyway cut.



Fixture used in milling Woodruff Keyways in Short Shaf·

VERTICAL SHAPER WORK

By J. M. HENRY

Several interesting examples of the application of vertical shapers to production work were shown in an article on page 483 of February MACHINERY. The vertical shaper has already achieved a position of considerable importance in the tool-room, and its scope of usefulness is gradually being extended to include production work. With the exception of the article referred to, however, very little has been published regarding the actual operation of this type of machine or the great variety of work for which it has proved adaptable. For this reason the writer believes that the examples of vertical shaper work shown in the present article will be of interest to a large number of MACHINERY'S readers.

In Fig. 1 is shown a typical vertical shaper job. The work consists of finishing the sides of eight square pockets in a four-armed block. The limit of accuracy, with respect to the size and squareness of the finished pockets, is 0.0005 inch. In addition to these exacting requirements, the sides of the pockets must be parallel with the sides of the arms and in alignment with the hole in the hub within very close limits.

Previous to the shaping operation, the bottoms of the pockets are finished and under-cut for tool clearance on a

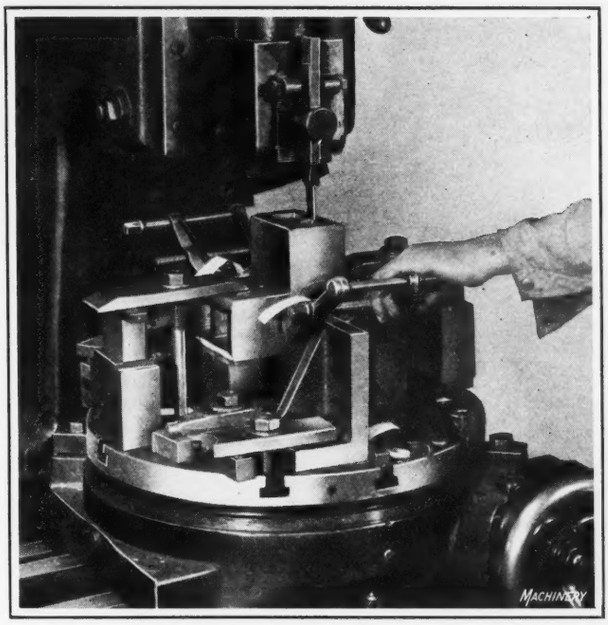


Fig. 1. Finishing Pockets in a Four-armed Block on a Vertical Shaper

profiling machine. The arms are also carefully machined to insure squareness and parallelism of the sides. It will be noted that the work is set up with two of the arms resting on height blocks so that the arm extending upward is brought into a vertical position. In order to locate the work squarely on the machine table, the arbor used to support the work during previous machining operations is clamped to angle-plates as shown. By locating and clamping the work in this manner the sides of the two pockets in the upward projecting arm are brought into the desired position for the machining operation. Roughing cuts are taken with a wide tool, while finishing cuts are taken with a fine-pointed tool. The same method of locating and clamping the work is used in machining the pockets in each of the four arms.

It may be of interest here to note some of the features of the vertical shaper that make it particularly well adapted for work of this nature. In the first place, the table is supported by a massive base which provides a firm surface on which to clamp the work. This rigidly supported base is located directly beneath the vertical ram and consequently receives and absorbs the thrust of the tool so that there is practically no chance for inaccuracy due to springing or

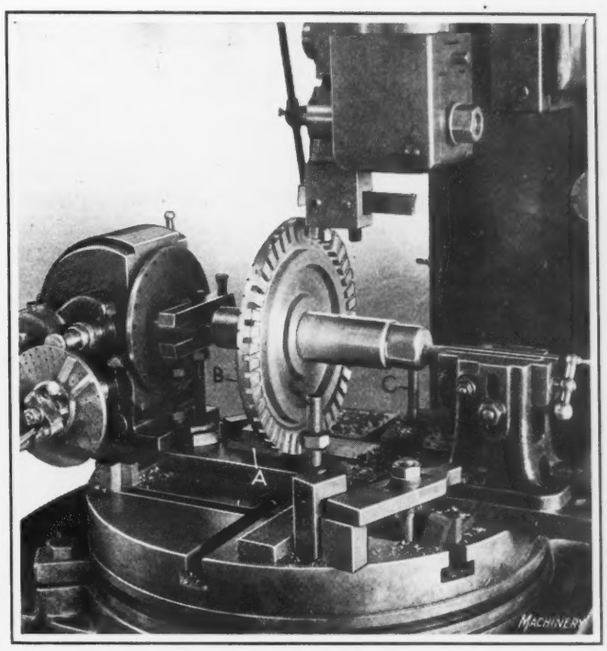


Fig. 2. Cutting Slots in an Index-plate

distortion of the machine frame. The provision of a rigid support for a tool close to the cutting edge, and the fact that the tool-head can be swiveled to any desired position are also advantages.

Slotting an Index-wheel

A rather unusual slotting job is illustrated in Fig. 2. The work consists of cutting the radial slots in an indexing wheel. It will be seen that the work is mounted on an arbor held between the centers of an indexing head. In this case the indexing head is employed simply as a means of supporting the work, the indexing being accomplished by means of a block *A* fitted into the T-slot of the index-head bedplate. This block was designed to engage radial slots *B* which were previously cut on a milling machine. The larger slots which were to be cut on the vertical shaper were required to be spaced exactly midway between the slots *B* on the opposite side of the work. Under these conditions the simple method of indexing by means of block *A* gave very accurate

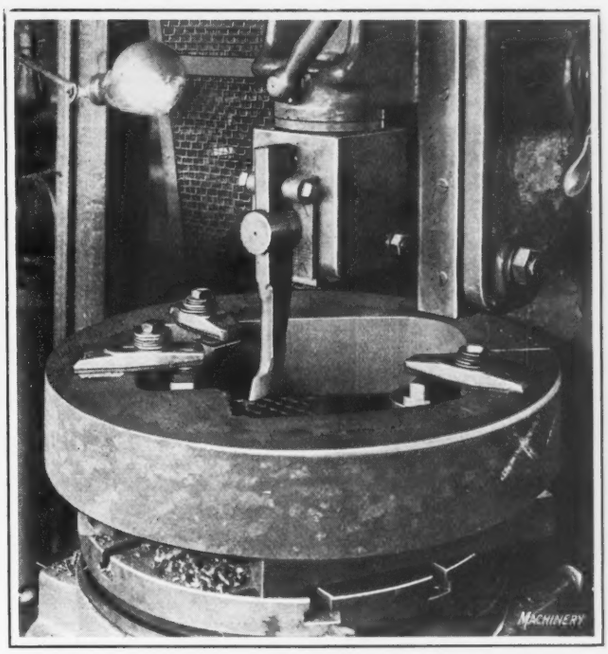


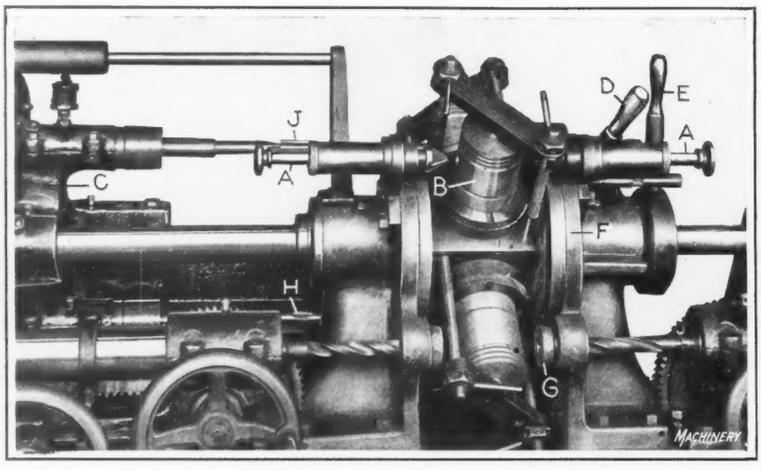
Fig. 3. Machining Opening in Large Blanking Die

results. It is evident that uniformly spaced radial slots could also be cut by employing the indexing head mechanism.

During the slotting operation a parallel supports the front face of the work and prevents the indexing block *A* from springing or distorting the work. The parallel is held in place by bolts *C*, but in order to give a better view of the work, it is not shown in the illustration. The slots are first roughed out and squared with the tool shown in the illustration, leaving 0.002 inch for finishing. The finishing operation is performed with a carbon steel tool, which cuts the slot accurately to size at one stroke. In the finishing operation the tool is stopped at the end of the down stroke and not allowed to draw back over the work. The work is indexed by means of block *A* after each down stroke of the finishing tool. The slots cut in this way are all held to size within a limit of one-quarter thousandth of an inch.

Machining a Large Blanking Die

In Fig. 3 is shown a large blanking die, the opening in which was completely finished in one setting on a vertical shaper. One advantage of the vertical shaper in performing work of this kind is that the tool enters the work on the top face of the die on which the outline or guide lines are usually made. One of the features which also makes the vertical shaper well adapted to die work of this kind is the angular adjustment of the ram. This enables the die opening to be machined with the clearance required to permit the piece blanked by the finished die to drop through the opening. The provision of means for rotating the table and for feeding it either longitudinally or transversely is obviously indispensable in work of this kind



Horizontal Machine with Turret for accommodating Four Pistons, used for machining Wrist-pin Holes

* * *

GERMAN INDUSTRIAL CONDITIONS

A review of the German industrial situation published by the Department of Commerce indicates that the peak of the industrial boom in Germany, which was reached last fall, has been followed by a considerable decrease of activity. The chief factors in the present situation are that there is an approach to the world's market prices which hampers the foreign trade, and the beginning of a reaction in domestic trade following domestic overbuying. Furthermore, the conditions are influenced by the uncertainty as to the future value of the mark, and the adverse effect on Germany's export trade of the fluctuating price system due to this uncertainty. There is also a considerable delay in deliveries, owing to the difficulty of obtaining raw materials and semi-finished products, and money is not so easy as in the past. Further, the export taxes act as a brake upon the foreign trade. The bulletin states that in machine tools the world market price is already reached in certain lines, and as a result there has been a decline in export orders, so that these are now only about 20 per cent of the orders on hand during the peak of the boom last fall. The bulletin concludes that the German industry is apparently confronted with an immediate slump in domestic and export business.

MACHINING PISTON-PIN HOLES IN A REPAIR SHOP

In some of the shops engaged in cylinder regrinding and general automobile repair work, this work is done on such an extensive scale that regular productive machines rather than the make-shift methods sometimes found in repair shops are used in the manufacture of over-size pistons. This is the case in the shop of the Houpert Machine Co., Long Island City, where methods are comparable to those found in an automobile manufacturing plant. The methods used for making over-size pistons in this shop comprise rough- and finish-boring the open ends on a Jones & Lamson turret lathe, rough-drilling the piston-pin hole 1/32 inch under size on a Garvin duplex milling machine, rough-turning on Gridley automatics, finish-turning on Fay automatics, and machining the piston-pin hole on the special machine here illustrated. After the piston-pin holes have been machined, minor operations such as drilling oil-holes, milling reliefs, etc., are performed and then the pistons are sent to the semi-finished stock-bins. The interesting features of the piston-pin hole machine are described in this article.

The machine is of the horizontal type with a four-station, vertically revolving turret, so that the work of drilling, boring, and reaming the piston-pin holes may be continuously performed. The turret-head is square and may be set up with proper open-end locating plates to suit the open end of pistons of any regular diameter. In setting up this machine the stations are built up to the proper height by means of plates, these plates fitting over a pilot projecting through each face of the turret. The plates are fitted together by tongue and groove construction, and the top or open-end plate fits accurately into the previously bored piston skirt.

After the proper height has been determined, two 60-degree centers operated by push-rods *A* are advanced to properly locate the piston from the rough-drilled piston-pin hole. The four pistons are clamped down by straps as shown, the work of loading a piston at station *B* being performed while the other three pistons are being machined. At the first work station, opposed drill-heads are advanced to redrill the holes preparatory to boring and reaming. The feed for these two drill-heads is independent of the feed for carriage *C* in which the reamer and boring-bar are carried.

As soon as the tools have completed their operation on a piston, the turret is indexed 90 degrees by handle *D* and clamped by means of handle *E*. The drilling feed for both drill-heads is then engaged before the boring-bar and the reamer are started to feed. After drilling, the piston continues to be advanced to the boring and reaming positions, respectively, which are located at the rear of the machine. Locating bushings in the left-hand head *F* similar to the drill bushing *G* are provided for the pilots on the boring-bar *H* and inserted-tooth reamer *J*. The feeding time for the drills used on this machine can be made to agree easily and effectively with that of the reamer and the boring-bar, thus enabling a high rate of production to be obtained.

Following up Changes in Design

By HYMAN LEVINE

IN the manufacture of machinery it is frequently found advisable to make certain alterations in design for the improvement of the product. The alterations usually necessitate the correction of drawings, patterns, tools, records, catalogues, prices, and other items; and as these corrections cannot all be made at the same time or by the same man, the person in charge sometimes finds it a serious problem to make sure that they are promptly and accurately attended to.

The task becomes still more complicated when several alterations in design are put through at the same time, each affecting a different set of tools and records, and each requiring a different time for its completion. It is not wise to trust to memory in such cases, as it might result in the omission of some important item and consequent financial loss.

A simple and effective method of following up alterations in design has been developed by the engineering department of a mining machinery plant in the Middle West. This method requires the use of forms or blanks about 4 by 7 inches, which are perforated at the left side and inserted in a loose-leaf binder. A separate sheet is used for each alteration in order to avoid overlapping and confusion. At the top of the form is a space for writing in the alteration to be made, and beside it is a space for the date when the change was decided upon. Below this space at the left is a list of drawings and records that may be affected, and at the right is a list of blueprints and notifications that must be sent out to those who are either responsible for carrying the alterations through or who are otherwise interested in the matter. The column at the left of each list is for check marks, and that at the right is for the dates on which each item is checked off.

REDESIGN VALVE HEAD TO INCREASE PORT AREA AND CUT MACHINING COST. — 10/18/20

✓	TRACING OF PART	12-28	✓	ASSEMB. PRINTS FOLDER	8-25
✓	PART LIST	1-4-21		H. L. PRINTS	
✓	PURCHASE LIST		✓	RECORD PRINTS	11-1
✓	MASTER LIST	1-5		COST DEPT. PRINTS	
✓	COST LIST	1-5		PACKING PRINTS	
✓	PRICE LIST	X	✓	PATTERN SHOP	6-8
	EQUIPMENT LIST		✓	MACHINE SHOP	8-10
	PARTIAL ASSEMBLIES			BLACKSMITH SHOP	
	PUBLICITY ASSEMBLIES			JEWELL	
✓	GENERAL ASSEMBLIES	1-10	✓	N. Y. PUBLICITY	8-25
✓	ASSEMBLY NUMBERS	1-6	✓	N. Y. RECORD	8-25
	PART INCLUDED IN		✓	CANADA	8-25
✓	STOCK BOOK INDEX	1-14	✓	PHILLIPSBURG	8-25
✓	STOCK BOOK	1-14		NOTIFICATIONS	
				PARKHILL	
	OTHER MACH. USED ON		✓	REYNOLDS	10-18
			✓	WEAVER	10-18
✓	JIGS	8-20	✓	GETSCHOW	11-1
				LEVINE	
✓	PATTERN INDEX	6-12			
	TRACING INDEX				

Machinery

Fig. 1. Alteration Follow-up Record Sheet

○ NOTIFICATION ○ No. 236

From Engineering Dept. Date 10-18-20

To Purchasing Agent By H. Levine

Subject Change in Design

MACH.	Part No.	Drawing No.	
XP	11	10378	Valve head is obsolete. Order no more castings until further notice.

Fig. 2. Notification Slip used in following up Alterations in Design

When an alteration in design is decided upon, the person in charge of the follow-up makes a note at the top of the sheet, together with the date. Then the list of items is gone over carefully, and a check is placed in front of each one that is likely to be affected. As the work progresses, the date when each item is attended to is noted in the column at the right of the item. When the job is completed the sheet is filed away for future reference. This form reduces the strain on the memory, minimizes oversights, and assists in placing responsibility.

The form shown in Fig. 1 is a record of the changes that were made in the valve head of a pneumatic tool. It was decided to redesign this part so as to provide a larger port area for the passage of air and if possible make the changes in such a way that the production cost would be reduced. The various steps did not follow each other in rapid succession owing to business conditions. A note of the job and the date was first made. Check marks were then placed before each of the items likely to be affected. A notification such as that shown in Fig. 2, was next sent to the purchasing agent to prevent ordering castings of the old design. A similar notification was also sent to the shop superintendent to prevent over-production on this part and to recall the old pattern.

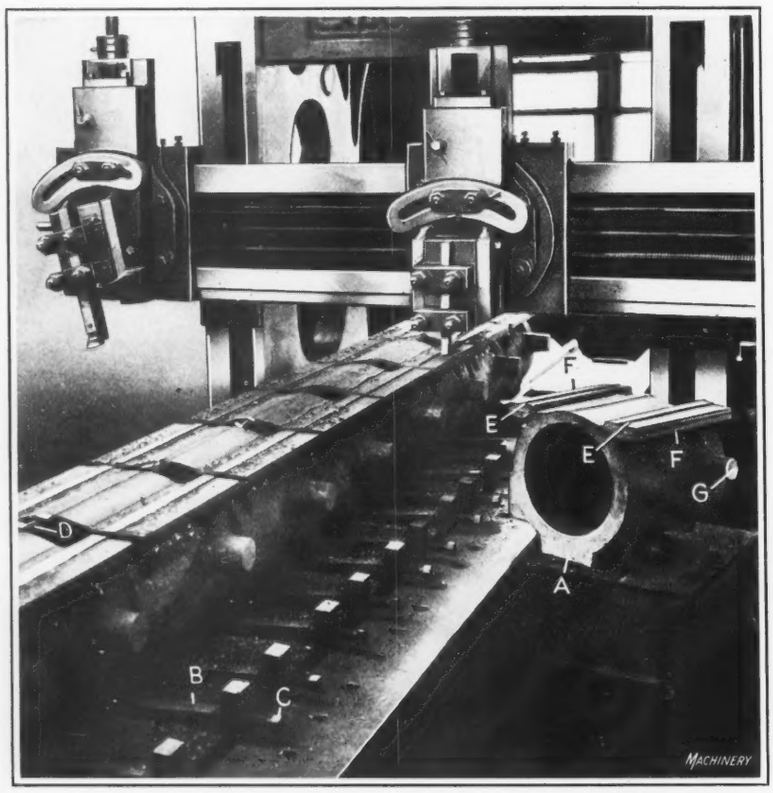
The dates on the follow-up sheet give the history of the alteration from the first to the final entry. The new design was drawn up and approved, and the drawings of the part were available on December 28, 1920. The changes made were such as to require the assignment of a new part number, and therefore it became necessary to note the change on the part lists of the machines on which the valve head is used, on the master list, and on the itemized cost sheets. These, it will be noted, were completed by January 5, 1911. The general assembly drawings of the several machines using this part, were then corrected and a new assembly number given the changed part. The stock-book and its index (a feature peculiar to this plant which was described

in detail in August, 1921, MACHINERY in the article, "Record of Materials Used in Machine Construction," page 1133) was also corrected. These were all drafting-room records, and were immediately taken care of. The other items, however, were more difficult to deal with.

There was a considerable quantity of old valve head castings to be used before employing the new design. Consequently blueprints were not sent to the pattern shop until June 8. It required six weeks to obtain the new castings, but as the old castings were not used until three weeks later, blueprints were not sent to the machine shop until August 10.

Within a few days one of the new valve heads was tried out, and as no changes were found necessary the design of a new jig was begun. When this was completed the necessary blueprints were sent to the tool-room. Blueprints were also sent to the New York, Phillipsburg, and Canada offices and to the publicity department. New blueprints were also inserted in the reference folder containing assembly prints of all machines manufactured at the plant. The first machine using the new valve head was completed and shipped November 1. A blueprint was filed with the records of that machine and a notification sent to the cost department for its guidance. It was decided not to change the selling price of the article, and the check after this item instead of the date indicates that no change was made.

It will be noted that more than a year was required to complete the changes. To have depended upon the memory in the case of each item might have resulted in serious omissions. Although this form was originally intended for changes in design, experience has shown that it can also be used to advantage in handling other jobs that come under the jurisdiction of the engineering department. The retracing of worn-out drawings, the furnishing of blueprints on special request, the preparation of sketches, and similar work are now noted and followed up by records on the form shown in Fig. 1. With slight changes this form can be adapted to use in the engineering and drafting departments of other plants.



Method of setting up Automatic Screw Machine Cylinder Castings for planing

PLANING CYLINDER CASINGS FOR AUTOMATIC SCREW MACHINES

In the accompanying illustration there is shown a 36- by 36-inch Cincinnati planer, which is engaged in planing cylinder casings for National Acme automatic screw machines. One of the finished casings is shown standing separately in order to illustrate more clearly the form of the work. A string of ten of these pieces is set up, each casting being supported on the planer table by means of the flat boss *A*. At each side of every casting in the string there is a finger *B* and clamping bolt *C* carried by a plug held in the table T-slot, provision being made in this manner for securing the castings against sidewise movement. These clamping fingers engage the boss *A* on opposite sides. Between each pair of castings there is a strap and hold-down bolt (not shown) to prevent the work from lifting; and a jack *D* to transmit the thrust of the tool from casting to casting is also placed between the ends of adjoining castings in the row. Then at the end of the string, this thrust is carried by a plug and bolt which are not shown in the illustration. On these castings, the operation to be performed consists of planing the base bearing *E*, the sides *F* of this base bearing, and the face of a boss *G* at each side of the casting. There are two tool-heads used on the planer, and a complete string of ten of the castings can be machined in 11½ hours.

* * *

STANDARDIZATION OF PULLEY SIZES

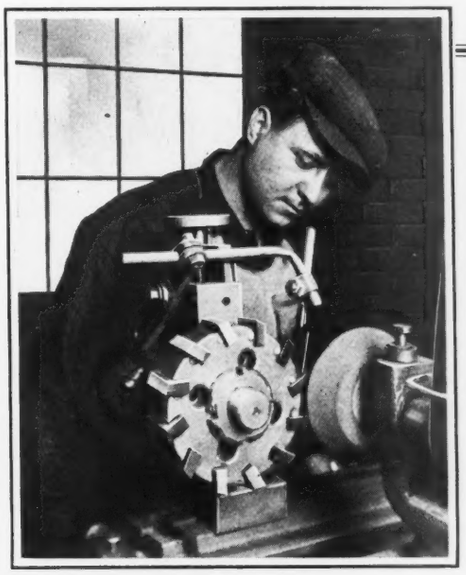
In connection with Mr. Hoover's plan of simplification in industry which means the elimination of commercially non-essential types, sizes, and styles, some of the pulley manufacturers have indicated that pulleys might be standardized to advantage. As far back as 1919, the Electric Power Club, 1017 Olive St., St. Louis, Mo., adopted specific pulley sizes as the recommended practice for use with each different size and speed of motor. This information is given in the Electric Power Club Handbook, copy of which may be obtained from Mr. S. N. Clarkson, executive secretary of the Electric Power Club.

There was some confusion due to the fact that the handbook specified belt width instead of pulley width, but at the annual meeting of the club held recently it was decided to add another column giving the pulley width in addition to the belt width, so that there should be no misunderstanding in future.

If the pulley sizes as adopted by the Electric Power Club were universally recognized, it would tend to standardize the different pulleys on the many machines which are sold for belt drive. As it is now, different manufacturers of machines have their own pulley sizes, and when the purchaser buys a motor to drive the machine, he must order a special pulley in order to obtain the right speed. This is one of the principal reasons why pulley manufacturers think that there are no standard pulley sizes for motors.

The Electric Power Club is an association consisting of the manufacturers that make over 95 per cent of the electric power apparatus and control equipment manufactured in this country. The Electric Power Club Handbook, that gives the pulley sizes referred to, also contains a great deal of other information relating to standards in the application of electrical machinery in the industries.

Grinding in the Small Tool Industry



Grinding Straightedges—Sharpening Cutters—Wheel Selection for Cutter Sharpening—Grinding Plug Gages, Micrometer Parts, Twist Drills, Taps and Dies, Lathe and Planer Tools

Third Installment of a Series of Five Articles on Grinding in Different Industries, by the Engineering and Educational Departments of the Norton Company, of Worcester, Mass.

MODERN grinding methods as applied to the making and sharpening of small tools are of great importance, especially in the machine-building industry. Nearly every shop engages to some extent in producing the various small tools which it uses in its manufacturing processes. This work is not usually thought of as an "industry" in the commonly accepted meaning of the word. On the other hand, there are many concerns engaged solely in the manufacture of small tools to meet the general manufacturing needs of other shops. Strictly speaking, these manufacturers make up the small tool industry which is rightly called a "key industry," because of the dependence upon it of nearly all other industries.

Owing to the varied nature of toolmaking practice, no attempt has been made to go into any great detail, but rather into fundamentals essential to the production of small tools. Grinding methods employed in tool-rooms of manufacturing plants are discussed, as well as those in shops making a specialty of small tool manufacture. The production of the wide range of precision tools in use today is made possible to a large extent by grinding. On account of the close limits imposed, some of the operations necessary in the making of tools cannot be placed upon a production basis in any other way than by grinding. Many tedious hand operations have been replaced entirely, or greatly reduced in duration, by the use of precision grinding machines, and much has been accomplished in the developing of machines adapted for different classes of work.

In modern manufacturing practice, straightedges are ground on a plane surface grinding machine, and further slight refinements which the machine is unable to give are obtained by lapping. An excellent example of the advantage of grinding over previous methods is in the quantity production of blades for combination squares. Three hundred of these blades each 12 inches long are mounted on a magnetic chuck, and the edges finished straight and square within very close limits. The outside limits prescribed for the guidance of the surface grinding machine operators in one shop are given in the accompanying table. As a matter of fact, the operators keep well within these limits.

A difficult operation is the finish-grinding of the blade of a 48-inch square (Fig. 1). The dimensions of the blade are: length, 48 inches; width, 4 inches; and thickness 5/32 inch. The edges are hardened and the center is soft. The long narrow edges must be straight and parallel with each other, as well as square with both sides. Great care must be exercised, not only to keep within the prescribed limits, but to avoid burning the edge of the square during grinding.

Fig. 1. Finish-grinding the Blade of a 48-inch Square

Fig. 2. Method of "Rough-squaring" Ends of Stock for Square Blades

A method of rough-squaring the ends of stock for combination square blades is shown in Fig. 2. The work is done on disk grinding machines, the disks being coated with aluminous abrasive grain. Combination square heads are very rapidly ground from the rough on a vertical-spindle surface grinding machine, as shown in Fig. 3. From 0.020 to 0.025 inch of cast iron is removed from each side of the square in this operation.

Fig. 3. Grinding the Heads of Combination Squares which are arranged in a Group on a Magnetic Chuck

The grinding of milling cutters of the plain, side and formed types constitutes a very important field of the grinding wheel and machine. Machines for grinding cutters vary from simple forms, designed for sharpening a few of the more generally used types, to universal tool and cutter grinding machines having a range which meets practically all requirements. For convenience in describing the common methods employed in the sharpening of cutters, they may be divided in three groups: plain cutters, side cutters and formed cutters.

LIMITS FOR STRAIGHTEDGES

Length of Straightedge, Inches	Limits, Inch	
	Straight	Parallel
Up to 24	0.00025	0.0005
25 to 36	0.0005	0.00075
37 to 72	0.00075	0.001
73 to 96	0.001	0.002

Machinery

Sharpening Plain Cutters

Sharpening a plain cutter is a comparatively simple operation and may be done on a machine consisting of a wheel-head and cross-slide for moving the wheel relative to the work, a means of traversing the cutter relative to the wheel, and a tooth-rest. The cutter is placed on the arbor, and the tooth-rest set to give the clearance desired. Whenever possible the rest should be against the tooth being ground. Cylindrical milling cutters are sometimes mounted on a sleeve for the grinding operation. The sleeve, in turn, is placed on a bar or arbor, which is held between the centers of the cutter grinding machine. In order that the edges of the teeth may be ground parallel, it is necessary that the bar or arbor and the sleeve be straight. It is good practice to grind two teeth, then rotate the cutter and grind two teeth on the opposite side and caliper to see if the machine is set straight. Then each tooth should be moved past the wheel with a steady motion and light cuts, using care to see that the cutting edges be kept radially equal.

To equalize the wear of the wheel, a good method is to grind around the cutter and then rotate it half way, beginning on a new tooth directly opposite the starting point and taking another cut through the complete circumference. By repeating this operation, taking light cuts, the wheel wear is equalized and the cutter is ground cylindrical.

Care should be observed in the method of grinding, that the cutter be kept "round." Each tooth should be moved past the wheel with a steady motion. Burning of the cutter teeth is caused by attempting to remove too much stock at one cut. About 0.003 inch of stock may be removed during the roughing operation, but this should be followed by a

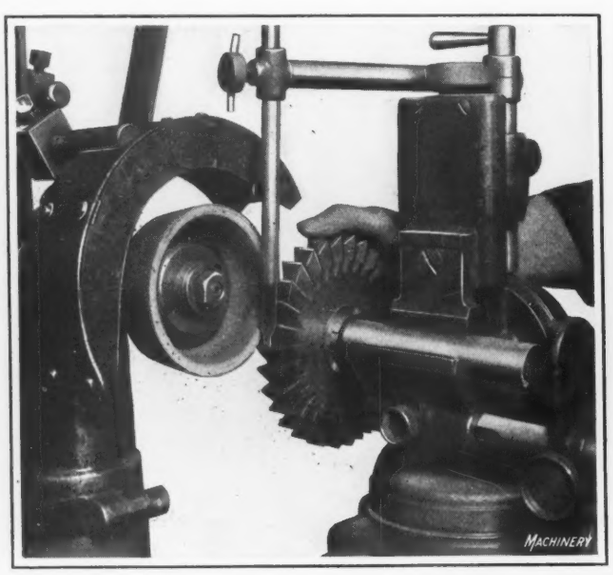


Fig. 4. Machine set up for grinding the Sides of a Side Mill

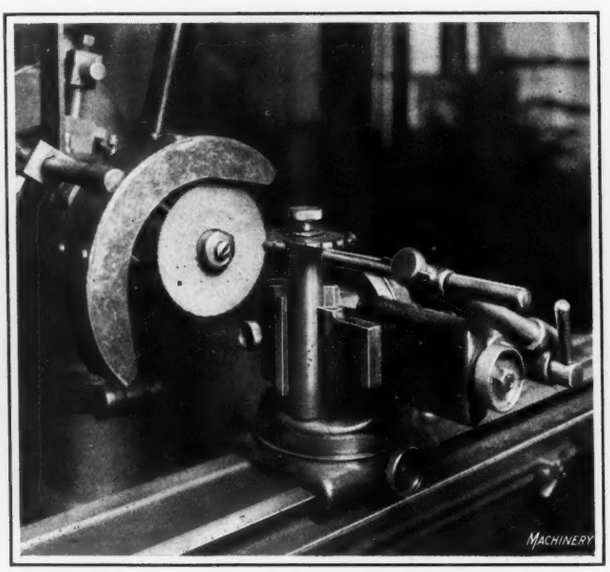


Fig. 5. Arrangement for grinding a Formed Cutter

Fig. 6. Cutting off Stellite Cutter Blades by using an Alundum Rubber-bonded Wheel

Fig. 7. Vertical-spindle Surface Grinder arranged for grinding the Sides of Stellite Cutter Blades

finishing cut of not over 0.001 inch in depth. The test of whether a cylindrical cutter is "round," or in other words whether the edges are within the surface of an imaginary right cylinder, is made by observing the sparks from the wheel as it comes into contact with the successive teeth.

Grinding Side Cutters and Formed Cutters

Cutters of the side-mill type are ground on the top exactly as with plain cutters. When grinding the sides of the teeth, a cup wheel is usually employed, the cutter being held on the end of an arbor and ground, as shown in Fig. 4.

Formed cutters are ground radially only, with a saucer wheel (see Fig. 5). The cutting edge must be kept in a radial plane, or else the cutter will not produce the intended shape. With this particular type of cutter it is necessary to grind with the rest at the back of the cutting tooth instead of in the usual position on the face.

In all cutter grinding the wheel must run true, and it should be kept clean, for a glazed or loaded wheel draws the temper quicker than one having a clean and true cutting surface. A diamond should be used for truing the wheel face.

Wheel Selection for Cutter Sharpening

The grinding wheel must be of a soft free-cutting grade so as not to draw the temper of the cutting edge and; for the same reason, the cut must be light and never forced. If the wheel is too soft its rapid wear makes it difficult to secure a sharp edge and maintain desired angles and dimensions. The work is usually ground dry. Wheels from grain 46 to 60 are best adapted for both high-speed and carbon steels. Finer wheels have a tendency to burn the work. The wheels most commonly furnished for plain milling cutters are of aluminous abrasives Grades J and K, although Grade I, vitrified and silicate, gives satisfaction, especially in saucer shapes such as Brown & Sharpe No. 60. Formed cutters are commonly sharpened with a saucer or dish wheel, generally Grade J or K vitrified aluminous abrasive.

Fig. 8. Grinding Angular Faces of Stellite Cutter Blade

Use of Disk and Cup Wheels for Grinding Milling Cutters

Considerable discussion and investigation has been given to the question as to whether the reliefs on the lands of milling cutters should be ground by disk or cup wheels. The small lines or grooves left on the lands of the cutter by a disk wheel are perpendicular to the cutting edge, while those left by a cup wheel are inclined at an angle with the cutting edge. A relief ground by a disk wheel is slightly concave, which is not true of the relief ground by a cup wheel. To avoid an excessive amount of concavity on the lands of the teeth, a disk wheel (if used) should be as large as it can be without striking the cutting edge of the following tooth and still produce the desired clearance angle; this strengthens the cutting edges.

Careful tests made of the cutting efficiency of cutters

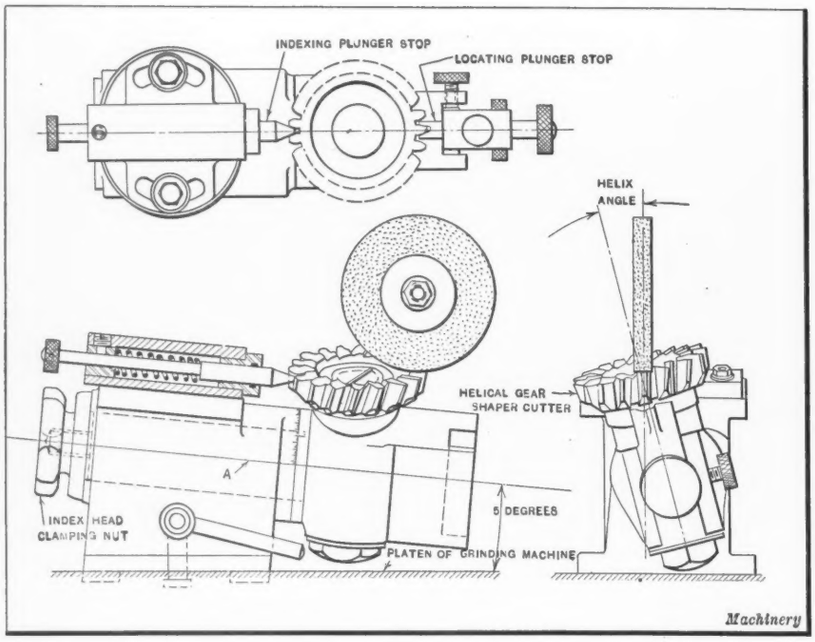


Fig. 9. Fixture for Use when sharpening a Helical Gear Shaper Cutter

of the same material and hardness ground under similar conditions by disk and cup wheels, have shown that the advantage of one type of wheel over the other is slight. In some tests, the cutter ground by a cup wheel proved to be somewhat more efficient. This, however, might be due to the particular material which was being machined, or to the fact that the cutting edge ground by the cup wheel is supported slightly better than that ground by the disk wheel, owing to the concavity left by the latter.

Grinding Stellite Cutter Blades

Cutting tools made of the non-ferrous alloy "stellite" are finding increased application in the machine tool industry. Owing to its properties, the most economical method of machining stellite is by grinding. Stellite is used extensively in cutter blades for milling. In one factory where considerable stellite is used for this purpose, the material is received in the form of bars having the dimensions 11 inches by ¾ inch by ½ inch. These bars are each cut into three pieces 3½ inches long, on a cutting-off grinding machine mounting an alundum rubber bonded wheel. The production of this machine is about 64 pieces per hour, and each wheel averages about 54 cuts before wearing out (Fig. 6).

The small pieces of stellite are then surface-ground on a vertical-spindle surface grinding machine (Fig. 7). About 25 pieces are ground on four of the six sides in one hour, the stock removed from each side being from 0.010 to 0.030 inch in depth, with a limit of accuracy of 0.001 inch. A wheel lasts about four days when grinding this material at the rate given. The three angular faces of the pieces are ground on a tool and cutter grinding machine (Fig. 8). The production averages about 42 pieces per hour for each of the three cuts. The cup wheel used has a life of about 1½ hours on this work.

Grinding Cutters for Spur-gear Shapers

The grinding of a spur-gear shaper cutter is usually done by one of two methods. One method involves the use of a universal grinding machine. The work is held by means of an expansion chuck, and is centered so that it runs true. The head of the machine is set at an angle at 85 degrees, in order to give 5 degrees of "top rake." The sharpening is accomplished by traversing the cutter past the face of the grinding wheel.

Whenever a rotary type surface grinding machine is available, it provides a better method of grinding spur-gear cutters. The cutter is centered by means of a close fitting brass plug, so that it runs true on the magnetic chuck. The work table is tilted at an angle of 5 degrees with its horizontal position, and the cutter sharpened by traversing the grinding wheel back and forth across the face of the cutter.

The diagram (Fig. 9) shows a method of sharpening a helical gear shaper cutter. There are two angular settings necessary. One angular position is the same as the helix angle of the cutter tooth, and the work-holding part of the fixture is adjusted about axis *A* to suit this angle. The other angle is according to the "top rake" required, the rake angle being obtained by setting the fixture at an angle of 5 degrees with the horizontal platen of the grinding machine.

Grinding Blades for Reamers and Inserted-tooth Milling Cutters

When grinding thin high-speed steel reamer blades, the principal problem is to keep the blades straight and cool during the grinding. Fig. 10 shows fixtures used for this purpose. The larger of the two fixtures was designed for use in grinding the surfaces of the blade; and the smaller, in grinding one of the edges of the blade, which is 0.031 inch lower than the other edge. Fig. 11 shows the larger fixture mounted upon the magnetic chuck of a surface grinder.

A method of grinding the hardened steel cutters for inserted-tooth milling cutters is shown in Fig. 12. Twenty-four of the cutters were placed on the magnetic chuck of a small surface grinding machine. From 0.012 to 0.015 inch of stock was removed from each side, the depth of cut being 0.003 inch. Both sides of the cutters were ground, so that a total of 0.030 inch of stock was removed from the thickness.

Grinding Plug Gages

From the manufacturing standpoint, the grinding operations on tolerance plug gages of high accuracy are second in importance only to the final lapping operation on the gaging ends. It is most essential that, in reducing the diameters to the desired oversize for lapping, the grinding be dependably uniform at all times. When the most efficient grade and grain of wheel for each operation is decided upon, the operator should be certain that the cutting action of wheels

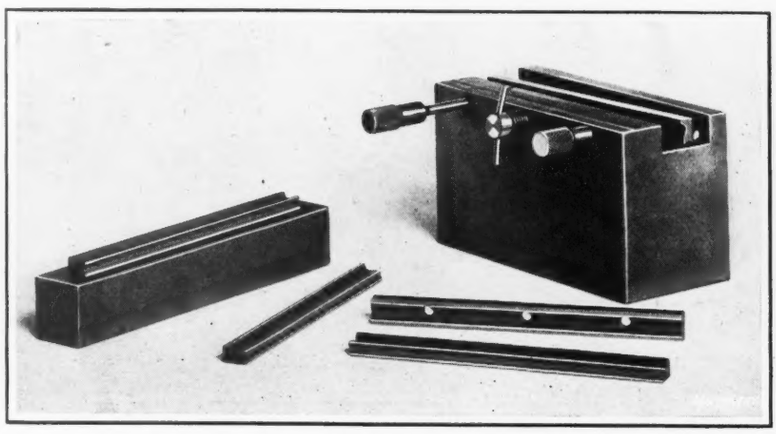


Fig. 10. Grinding Fixtures for Thin Reamer Blades

Fig. 11. Reamer Blade Fixture mounted on the Magnetic Chuck of a Surface Grinder

Fig. 12. Method of Grinding Hardened Steel Blades for Inserted-tooth Milling Cutters

received in successive lots, which are marked with the same grade and grain as the original wheel, will be, as far as possible, identically the same on all plugs he is to grind. If this can be depended upon, a great saving of time will result. The rough-grinding operation on two "Not Go" ends of a well-known type of plug gage is shown in Fig. 13, the two gaging ends being ground at the same time. On account of the great accuracy required, quantity production is not so important a factor as are uniform results and finish; consequently the time required to grind the plugs varies greatly, so that any production records on this class of work have little significance. The "Go" end of each plug is ground singly. After the gaging ends have been treated and seasoned, and before they are sent to the lapping department, they are finish-ground to various over sizes, depending upon the type and diameter of the gage. The finish size is as near to the final desired size as it is practical to go. This finish-grinding operation is of great importance. Not only should the amount of stock removed during each cut be absolutely under control, but great care should be observed in the grinding, as the progress made in the lapping operations depends to a considerable degree upon the finish left by grinding.

Grinding as Applied to Micrometer Manufacture

Some of the important grinding methods employed in the production of micrometers in one large plant manufacturing this class of tools, are illustrated in Figs. 14, 15, 16, and 17. The following list of operations shows to what extent grinding and lapping enters into the making of micrometer spindles: Grinding the neck of the screw; rough-grinding the spindle; grinding the outside diameter of the thread; finish-grinding the spindle; lapping the spindle; grinding and lapping the end of the spindle.

The micrometer spindles are ground in a small cylindrical grinding machine. The part ground on one type of spindle (Fig. 14) is 1½ inches long, the finish diameter is 0.235 inch, and the limit of accuracy is 0.0001 inch. Three hundred of these pieces are finish-ground in a nine-hour day. The ends of forty spindles are ground simultaneously in a

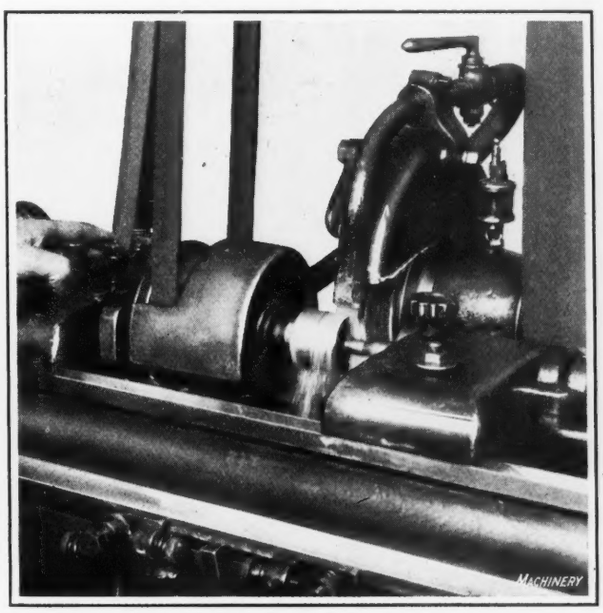


Fig. 13. Illustrating the Rough-grinding Operation on Two "Not Go" Ends for Plug Gages

Fig. 14. Grinding Micrometer Spindles with Small Cylindrical Grinding Machine

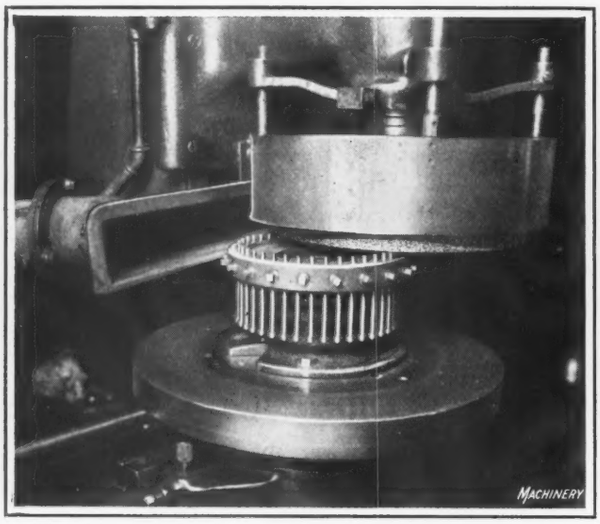


Fig. 15. Grinding Ends of Forty Micrometer Spindles simultaneously

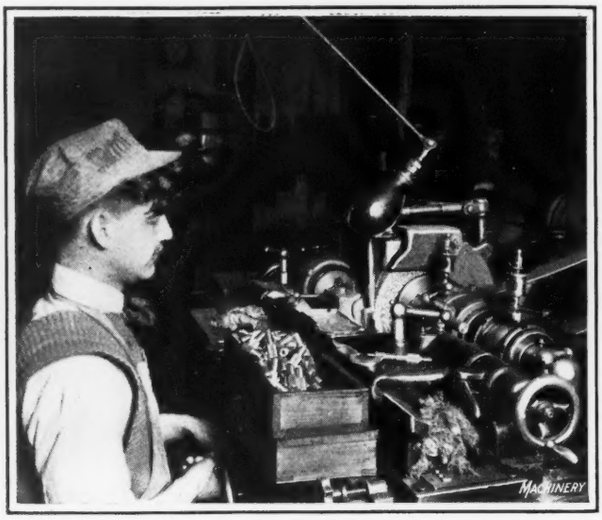


Fig. 16. Cylindrical Grinding Operation on Micrometer Barrel

vertical-spindle surface grinding machine (Fig. 15). The spindles are hard and the ends are rough. The rough-lapping operation on the ends is performed in the same rotary fixture shown.

Fig. 16 illustrates the cylindrical grinding of a micrometer barrel. From 0.012 to 0.015 inch of stock is removed in the grinding. A high degree of accuracy is required in this operation, in order that the graduations and figures which are placed on the sleeve later shall be uniform. The sides of micrometer frames are finish-ground on surface grinding machines, as shown in Fig. 17.

Twist Drill Grinding

Drills larger than $\frac{3}{8}$ inch in diameter are ground most economically by special drill grinding machines, while those smaller than $\frac{3}{8}$ inch in diameter are sometimes hand-ground. Fig. 18 shows a method of grinding a twist drill in a machine manufactured by the Washburn Shops of the Worcester Polytechnic Institute. The essential points in connection with drill grinding are:

1. The two cutting lips should be kept of equal length.
2. The cutting edges should be kept as straight as possible.
3. The cutting lips should form equal angles with the axis of the drill. The angle commonly used is 59 degrees.
4. There should be only just enough lip clearance back of the cutting edges.

The web of a twist drill is made thicker at the shank than at the point. The thicker it is the more thrust is required to feed the drill into the metal. This excessive thrust may cause a deflection in the drill press resulting in inaccuracy of work and loss of power in the transmission. Many experiments have been made with drills before and after the point has been thinned. In one such test, where a 2 13/16-inch drill with a web 11/32 inch thick was being used, it required two and one-half times more pressure to feed the drill before than after the web had been correctly thinned.

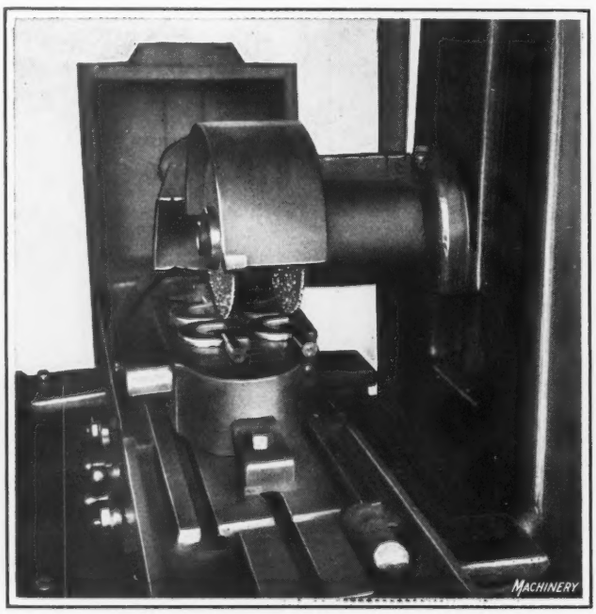


Fig. 17. Finish-grinding the Sides of Micrometer Frames

When thinning the point of a drill, it is essential to preserve the true center of the drill, and regardless of whether the web of the drill is exactly central or not, the distance from the outer end of each cutting edge to the termination near the center should be precisely the same. Sometimes, in the case of cheaper makes, a drill is not perfect when new, hence the importance of grinding the cutting edges the same length.

Care should be taken not to weaken the web by extending the ground portion too far up the flutes. The cutting edges should not be hollowed out by the point thinning. No attempt should be made to give "rake" to the cutting edges near the center, for this part of the drill revolves at such a slow cutting speed that the rake is not important. Point thinning must be done with a round-face wheel, to which the drill should be presented so that the grinding begins on the curved portion of the flute. It may then be rotated by hand until the proper point is obtained. The "point thinning" of small drills is a delicate and difficult operation, and is not advisable on drills below about $\frac{3}{8}$ inch in diameter.

Wheels for Drill Grinding

Wheels for drill grinding should be fairly soft and open so that they will not clog, or burn the work. To avoid burning when grinding dry, the work should bear very lightly against the wheel. The surface being ground should be carefully watched in order to detect any drawing of the temper. Wheels furnished for various twist drill grinding machines are all of aluminous abrasive and include silicate 46-M; elastic 36-4; vitrified, 46-K, L and M.

Grinding of Taps

Needless waste can be avoided by regrinding dull taps. The methods employed may be listed as follows: (1) Squaring the end of the tap on the face of an ordinary tool grinding wheel; (2) Grinding the relief or chamfer, giving radial clearance or relief; (3) Grinding the flutes.

As a general rule, taps should be resharpened after having tapped 500 holes. The length of time that taps may be used before becoming dull, however, may vary widely, as it depends upon the kind of work on which the tap is used and also upon the quality of the tap.

The relief of the tap becomes dull first, and usually the only sharpening necessary is that of the relief. The tap is held lightly against the face of the grinding wheel, which should turn toward the cutting edge of the tool as shown in Fig. 19. The radial relief is obtained by turning the tool slightly in the hand, so that a little more will be ground off the back of the teeth than off the cutting edge. The chamfer is usually ground four or five teeth back. If the cutting edges of the teeth become dull, nicked or burred, it is necessary to grind in the flutes with a properly formed wheel.

The various makes of tool and cutter-grinding machines provide means for holding taps for flute grinding. As the cutting edge is very thin, extreme caution must be exercised not to change the temper of the steel. This danger of ruining the tap is practically eliminated by very light pressure and the use of a cool cutting wheel. A broken tooth does not render a tap useless; if all pieces of the tooth are carefully ground out, leaving no jagged edges to tear the thread, the efficiency of the tap as a threading tool is reduced but slightly.

Grinding Blanking and Forming Dies

The various classes of die grinding may be grouped under the following heads: Cylindrical, internal, surface, groove or form, and miscellaneous.

Cylindrical grinding is confined almost entirely to the grinding of punches, both straight and tapered. A universal or small cylindrical grinding machine is generally used and the grinding may be done wet or dry. Internal grinding is done on blanking and forming dies where an accurate internal surface is desired. The object of this form of internal grinding is to produce a clearance or to remove any irregularities caused by the shrinkage of dies after hardening.

Surface grinding of dies may be done either on horizontal- or vertical-spindle surface grinding machines. Much of the heavier surface work is done by means of flexible shaft machines or floor and bench stands equipped with surface grinding attachments. Grooving and form grinding of dies are special operations applicable to particular jobs.

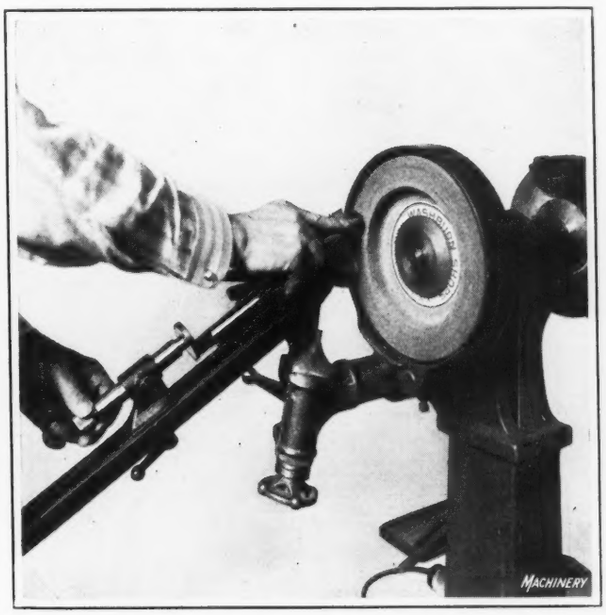


Fig. 18. Typical Example of Twist Drill Grinding

Fig. 19. Grinding the Relief of a Tap by Hand

The field of the small flexible shaft machine and the portable electric grinding machine in die grinding is almost unlimited. Small specially shaped wheels are used for all classes of irregular stamping, blanking or drop-forging patterns, and also on threading dies. Small portable machines are used for some of this work, but the flexible type is more adaptable to the varying kinds of work.

The spring die chaser or thread chaser has all of the elements of a tap turned inside out. The throat or chamfer of the die is ground by the use of a small cone-shaped wheel. The cutting edges or faces of the spring die are ground by dish wheels.

Grinding Lathe and Planer Tools

Lathe and planer tools are ground both by the freehand method and by automatic tool grinding machines. The machine method is safer and more satisfactory, unless the operator has exceptional skill. It has been found that machine grinding saves the workman's time, reduces the time lathes and planers stand idle while tools are being ground, gives the correct grinding angles, increases the life of the tool, increases production, raises the quality of the work, and permits a smaller investment in high-speed steels. Although the question is still open to considerable debate, most authorities favor wet grinding of lathe and planer tools. When grinding wet, a stream of water sufficient to take up the heat as fast as it is generated must flow at low velocity directly upon the nose of the tool. Five gallons a minute is good practice. A little water is worse than no water at all, as it is often the direct cause of surface cracks. Grinding should not be done too forcibly, as the water is thus kept away temporarily from the work surface so that when the tool is released the cool water strikes the hot metal causing it to surface-crack.

Arbor Grinding

The general practice among manufacturers is to harden arbors all over. For very accurate work, however, an arbor having hardened ends and a soft body is considered preferable, because there is less tendency toward distortion as a result of internal stresses. The cylindrical parts of arbors are rough-ground, and the arbors should be allowed to "season" before the finish-grinding operation. The "seasoning" is necessary on account of the stresses which are caused by the hardening operation.

LINE-REAMING

By CASPER J. DORER, Chief Tool Designer, White Sewing Machine Co., Cleveland, Ohio

Line-reaming to obtain accurate alignment of bearings is a subject of frequent discussion. Many tool designers believe that the part to be line-reamed should be held or clamped rigidly in place while the reamer is passed through the holes. Others contend that it is better to allow either the work or the tool to float, or to allow both the work and the tool to float. Each of these methods doubtless has its respective merits which particularly recommend it for use under certain conditions that should always be considered.

The fixture shown in the accompanying illustrations is of the type that allows both the work and the reamer to float. This fixture has been the means of eliminating much of the trouble previously experienced in reaming the holes in the part shown at *A*, Fig. 1. It represents a complete departure in design from that previously employed. Production has been greatly increased by its use, and no difficulty is experienced in holding the work within the required limits of accuracy.

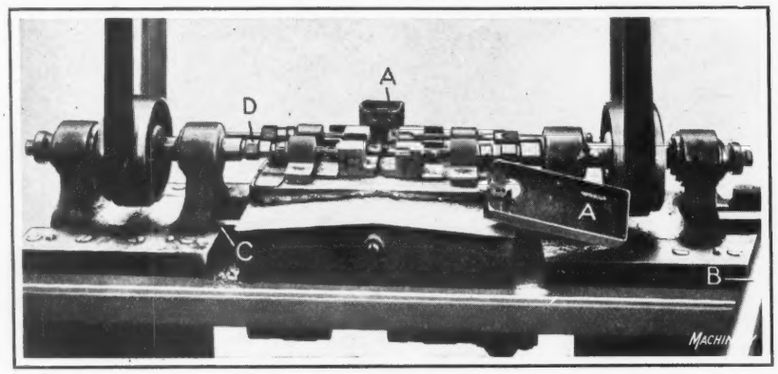


Fig. 1. Line-reaming Fixture employed on Two-spindle Machine

The work consists of reaming two holes in each end of the box-shaped casting *A*. The opposite holes in this casting are required to be in alignment within limits of plus or minus 0.001 inch. The machine on which the fixture is mounted has two opposed spindles which are fed inward by means of a hand-lever *B* and rack *C*. The reamers are held in chucks *D* by pins which pass through the chuck and reamer shank at right angles to the axis of the spindle. The driving pin in one of these chucks is shown at *E*, Fig. 2. A clearance of 1/64 inch is allowed between the shank of the reamer and the hole in the chuck, to permit the reamer to float freely.

The reamers *F* are constructed with pilots or bearing surfaces at each side of the cutting portion. These pilots are fluted to provide clearance for chips and are made a running fit in bushings *G* and *H*. The teeth are end-cutting, being taper ground for about ¼ inch. The forward pilot of each reamer is about 0.003 inch smaller than the size of the drilled hole in the work. The pilot or shank at the rear of the cutting teeth is about 0.002 inch larger than the teeth of the reamer. Both pilots of each reamer are supported in their respective bushings before the teeth begin to cut.

The casting, which is represented by the dot-and-dash lines at *P*, Fig. 2, is drilled from 0.010 to 0.012 inch under size to allow for finish reaming. The work is laid on the fixture and is loosely located by means of the L-shaped blocks *K* and the heads of bushings *H*. When the reamers pass through the holes the work is lifted slightly from its position on the L-shaped blocks and drawn away from the vertical sides of these blocks thus causing the piece to float completely while the hole is being reamed. As a result of this floating action, no strains are developed in the casting during the reaming operation. The four bushings that support the two reamers are, of course, in accurate alignment.

After line-reaming one set of holes, the second set, which is of smaller diameter, is reamed in the same manner by inserting smaller reamers in the spindles and moving the fixture forward so that bushings *J* come into alignment with the spindles of the machine. Set-screws *L* serve as stops for aligning the fixture with the spindles. These adjusting screws are locked in place by lock-nuts *M*. The fixture is slotted to receive the locking nuts or studs *N*, which clamp the fixture in place after it has been adjusted for reaming either the large or small holes. The sheet-iron aprons *R* keep the chips and dust from falling on the bearing surfaces of the fixture. With this fixture one operator can ream 350 pairs of holes per hour.

* * *

PRODUCTIVE AND NON-PRODUCTIVE LABOR

Every man and woman necessary to the conduct of a business, whether carried on the office or shop payrolls, is productive so far as results are concerned. In the past it has been the custom to divide labor into productive and non-productive classes, but this classification seems to be entirely erroneous. The so-called "non-productive" man is just as essential to the success of the enterprise and to the manufacture of the product as the productive man. If he is not, his services should be dispensed with. A better classification that has been proposed by a man prominent in the industry, is "direct" and "indirect" labor, the direct labor being engaged in specific operations on the product, while indirect labor is that which cannot be so classified. By so dividing labor costs, it is possible to charge overhead in the proper proportion.

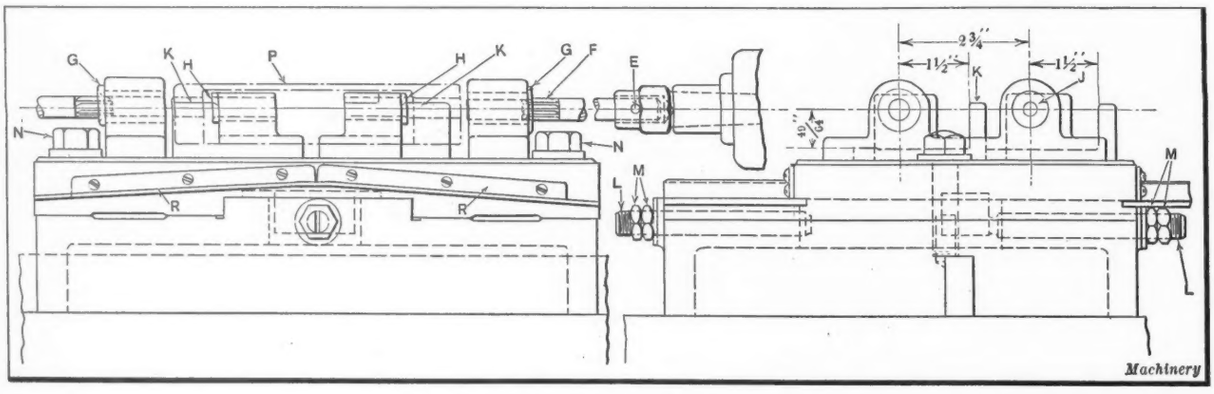
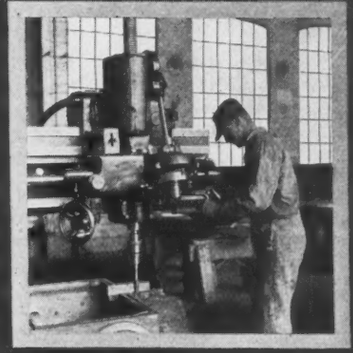


Fig. 2. Front and End Views of Line-reaming Fixture shown in Fig. 1

Letters on Practical Subjects



AIR CHUCK FOR IRREGULAR CASTING

The special chuck developed in the plant of the Delco Light Co., Dayton, Ohio, for holding an irregular shaped casting is shown in the illustration. The irregular shape of the part is shown by the four views in the upper left hand corner. It would be difficult to hold this work in a plain chuck without crushing the walls or distorting the part. The special chuck overcomes these difficulties satisfactorily, and has been in use for some time on a 1½-inch Acme hand screw machine.

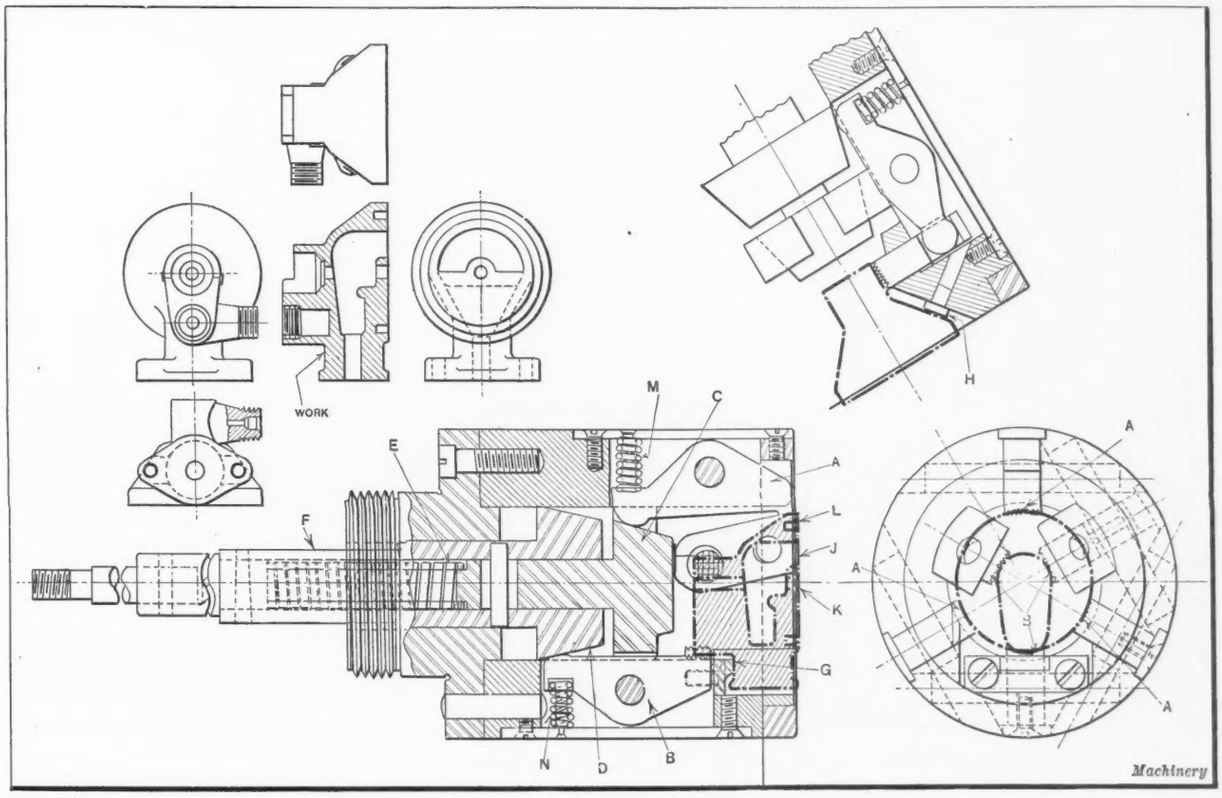
One set of three jaws *A* holds the casting by the outer rim, and another set of jaws *B* holds the elliptical shaped part. The two upper jaws of the latter set are fixed, and the lower one acts as a clamp. These clamping jaws are moved in toward the center by means of lever arms which are actuated by two cones *C* and *D*. The shaft of the rear cone *D* is bored out to form a recess in which is placed a spring *E* that fits over the plunger of the forward cone *C*. When the air pressure is turned on, the rear cone and its shaft move forward, causing clamping jaw *B* to grip the casting against the upper jaws. At the same time the front cone moves forward causing clamps *A* around the outer edge of the casting to close in.

As this takes place the spring *E* is compressed. The spring is designed to exert about half the pressure exerted by the air on the end of the rear cone shaft *F*. This equalizes the pressure on the jaws so that the casting is held firmly in place. Springs *M* and *N* are used to force the jaws outward when the air is released. When the casting is placed in the chuck by the operator, it is pushed back against stops *G* and *H*. The operations performed on the work when it is held in the chuck in the position indicated by the heavy dot-and-dash lines are facing surface *J*, drilling and reaming hole *K*, and counterboring recess *L*.

Dayton, Ohio. EDWARD H. TINGLEY

DRILL FOR WOODEN BLOCKS

In the plant of a specialty manufacturer, large quantities of small wooden blocks were being drilled in an automatic machine at the rate of seventy-five per minute. The blocks were of very dry beech wood. The dryness of the wood and the fact that the hole was required to be quite near the end of the piece made it difficult to prevent many of the pieces from splitting during the drilling operation. While an ordinary lip bit such as carpenters use would do the work without excessive splitting, it would not finish the bottom of the hole to the desired shape. The hole was cut half way



Air-operated Chuck with Two Sets of Jaws for holding an Irregular-shaped Casting

through at the sides and the countersunk shape at the bottom was required to be clean cut with no wood splitting.

After trying all the specially designed bits and drills obtainable, the manufacturer decided that an ordinary twist drill gave the best average service, although his rejections of split blocks was still considerable. Quite by accident he noticed an illustration of a drill designed to cut marble, which is described and illustrated on page 1116 of MACHINERY'S HANDBOOK. Experiments with a drill of this type proved very successful. At a speed of 3200 revolutions per minute this drill is now producing the holes in the wooden blocks with a maximum rejection of only 1 per cent.

Middletown, N. Y. DONALD A. HAMPSON

CALCULATING DIAMETER AT INTERSECTION OF TWO TAPERS

When two tapers are formed on a piece of work as shown in Fig. 1 or Fig. 2, it is sometimes necessary to determine the length of each taper and the diameter at the point where the two tapers join. This problem may involve the conditions shown in Fig. 1 or those shown in Fig. 2. Referring to Fig. 1, it will be noticed that the section having the larger taper is at the top, while in Fig. 2 the section having the larger taper is at the bottom. Considering the problem as presented in Fig. 1, let

R = radius at large end of piece;
r = radius at small end of piece;
a = angle of taper at large end;
b = angle of taper at small end; and
H = height of piece.

The problem is to find the length J of the tapered section at the large end, and the radius x at the intersection of the two tapers. From Fig. 1 we see that

$$D = H \tan b \text{ and } F = D + r - R$$

$$f = 90 \text{ degrees} - b \text{ and } g = 90 \text{ degrees} - a$$

In the small diagram in the upper right-hand corner, $km = 1$ inch. Now as angle lkm = angle b as shown in the large diagram, and angle nkm = angle a; it follows that the geometrical figure $LKMN$ is similar to the small geometrical figure $lkmn$. Therefore, according to trigonometry, we have

$$T = \cot f \text{ and } S = \cot g$$

Therefore,

$$P = \cot f - \cot g$$

Now in the two similar geometrical figures we have

$$F:J::P:1$$

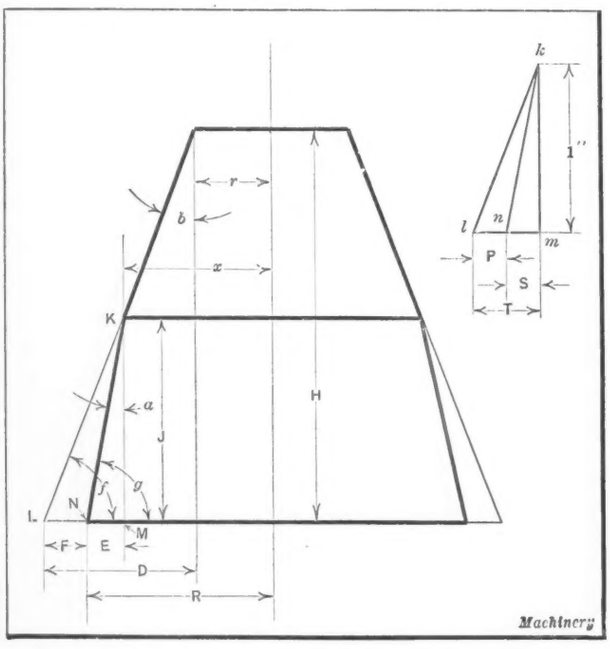


Fig. 1. Diagram used in calculating Diameter at Intersection of Two Tapers

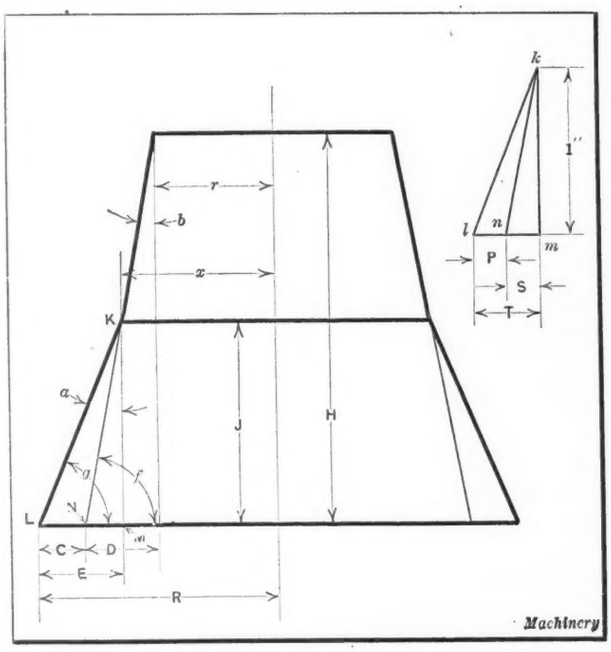


Fig. 2. Diagram showing Problem Similar to that presented in Fig. 1

Thus,

$$PJ = F \text{ and } J = \frac{F}{P} = \frac{D + r - R}{\cot f - \cot g}$$

By trigonometry $E = J \tan a$, and by subtraction $x = R - E$ and $2x$ = diameter at the intersection of the two tapers.

Referring to Fig. 2 illustrating the case in which the large taper is at the bottom end of the piece, let

R = radius at large end of piece;
r = radius at small end of piece;
a = angle of large taper;
b = angle of small taper; and
H = height of piece.

The problem is to find the height J of the tapered section at the large end, and the radius x at the intersection of the two tapers. In the illustration Fig. 2,

$$D = H \tan b \text{ and } C = R - D - r$$

Also,

$$f = 90 \text{ degrees} - b \text{ and } g = 90 \text{ degrees} - a$$

Referring to the small triangle in the upper right-hand corner, angle lkm = angle a in the larger figure, and angle nkm = angle b.

According to trigonometry

$$T = \cot g \text{ and } S = \cot f$$

Therefore,

$$P = \cot g - \cot f$$

Considering the two similar geometrical figures, we have

$$C:J::P:1$$

Thus,

$$PJ = C \text{ and } J = \frac{C}{P} = \frac{R - D - r}{\cot g - \cot f}$$

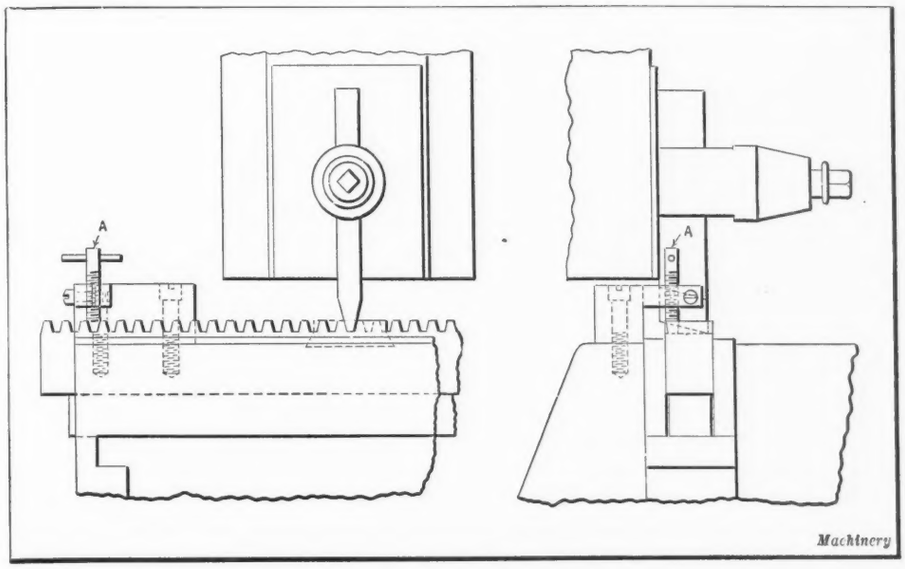
Therefore,

$E = J \tan a$ and $x = R - E$, and $2x$ = the diameter at the intersection of the two tapered sections.

Flint, Mich. W. G. HOLMES

REPLACING BROKEN RACK TEETH

In repairing machine shop equipment, it is often necessary to dovetail a piece into a rack in order to replace broken teeth. The simple fixture shown herewith can be attached to a shaper vise for cutting the teeth in the dovetailed piece. With this device the cutting can be done by an apprentice. In cutting the teeth, a tool is first selected of the proper shape and adjusted to fit the rack tooth space next to the dovetailed piece. The vise jaws are then opened and the



Fixture used in cutting Rack Teeth when replacing a Broken Section

rack moved along one tooth, the point of screw *A* serving as an indexing or spacing pin.

The first tooth space in the inserted piece is then cut to the proper depth as determined when setting the tool in the tooth space next to the patch. This operation is repeated until all the new teeth are cut. A similar method can be used in repairing gears that are too large to be cut in a milling machine, the gears being mounted on a stud attached to the shaper platen. This method will often obviate the necessity of sending a gear outside the plant to be recut or of ordering a new one and thereby forcing a productive machine to remain idle for an indefinite length of time.

Roslindale, Boston, Mass. CHARLES H. JACKSON

MOLD FOR RESERVOIR HAVING A LARGE CORED CHAMBER

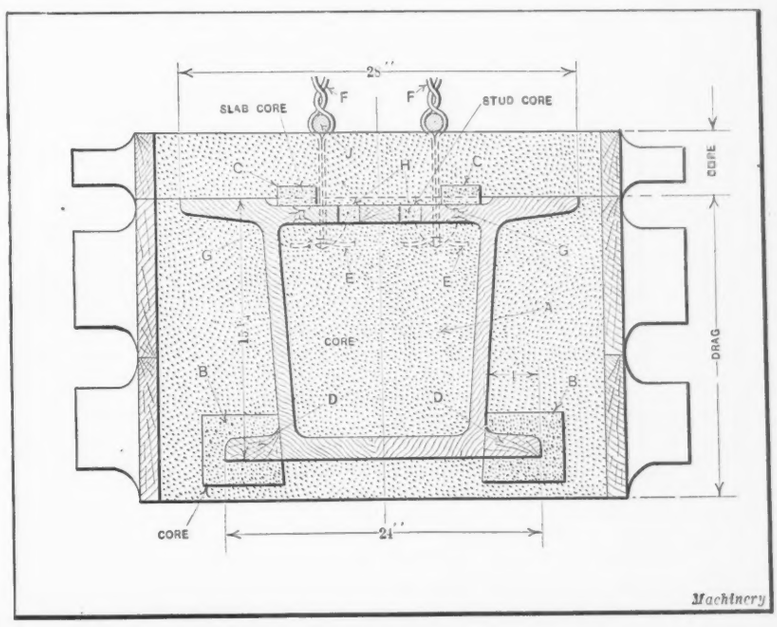
In the accompanying illustration is shown a cross-sectional view of the pattern and mold used in the production of a casting having a large cored chamber which serves as a water reservoir. The body of the reservoir is practically square in section and slightly tapering. The large flanged end of the casting is actually the base, but from the illustration it will be noted that the mold is constructed so that the reservoir is cast in an inverted position. The pieces forming the top flange of the pattern are loosely attached, while the bottom flange is made solid with the body of the pattern. The method of supporting the heavy core *A*, the making of the flange cores *B*, and the provision of proper means of carrying off the gases from the core are points of particular interest.

The pattern was intended to be molded in green sand, using a dry sand core *A* for the chamber. As the top flange was quite wide, dry sand cores *B* were made and placed in the mold as shown. No core-box was made for this purpose, a substitute being formed by placing one of the flanges on an iron core-drying plate with a temporary box built around the flange. The walls of a core of this kind may be made any convenient thickness. In foundry practice, such a core is referred to as a "ram-up-core."

In molding, the pattern was first placed on the bottom board with the large flange in contact with the board. Sand was then shoveled into the flask up to the flange cores *B*. The flanges were then placed in the cores and assembled in their original position on the body pattern, and the filling in of the sand continued up to the top of the drag flask. The drag flask was then turned over and made ready for the cope. Before filling the cope with sand, the dry sand slab cores *C* were placed on the pattern in the position shown. The purpose of these cores will be explained later. After going through the usual process of sand-filling, ramming, venting, gating, etc., the cope flask was lifted and the pattern drawn out, the flanges *D* (one at each side) being drawn in and up through the mold. This leaves cores *B* properly located.

In making the core *A*, four anchor wires *E* were embedded in the core about two inches below the top or cope-face. Sand was dug out above these wires and a pocket formed, as shown by the dotted lines. Wires *F* were fastened to the anchor wires, and core *A* was lowered down into the mold. Chaplets *G* were placed on the top of core *A* as illustrated. To provide means for carrying off the gases, four equally spaced 2-inch stud cores *H* were placed on top of core *A*. In closing the mold, the four wires *F* were passed up through the sand of the cope and the latter member lowered into contact with the drag by means of the protruding ends of the wires *F*. Core *A* was then carefully raised until the chaplets *G* came up against the slab cores *C* in the cope. The end of the wires *F* was next wrapped around and securely fastened to the bars *J*, which were placed across the sides of the flask. The vents for core *A* were then made through the stud cores *H*. It will be evident that the slab cores *C* were rammed up in the cope mold in order to provide a firm backing for the chaplets *G*. If placed in contact with green sand, these chaplets would have been worthless. The sand that formed core *A* was shaken and worked out of the casting through the holes left by studs *G*. When the casting reached the machine shop, the four 2-inch holes were tapped and plugged, thus completing the job.

Kenosha, Wis. M. E. DUGGAN



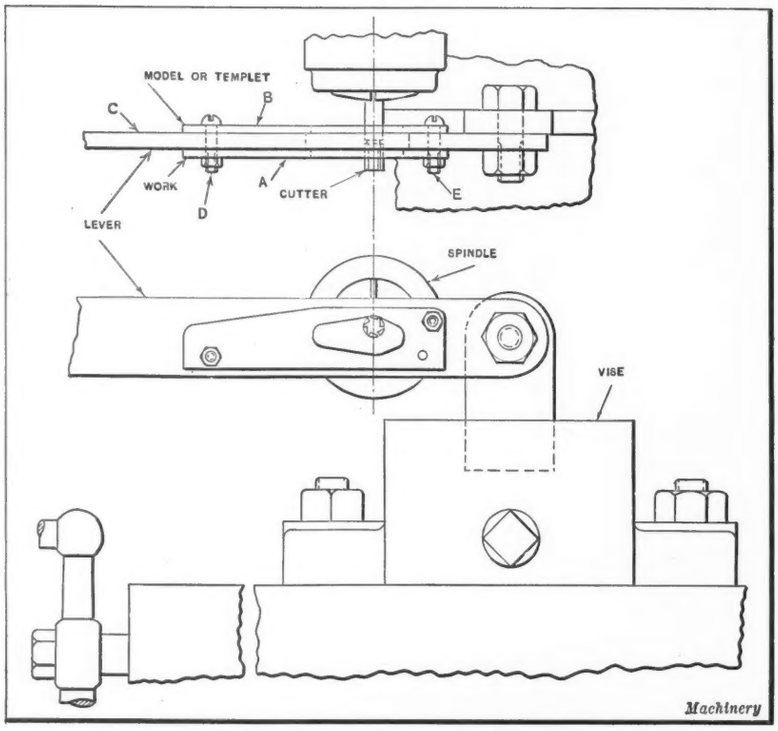
Sectional View of Pattern and Mold for a Large Cored Chamber

MILLING PROFILE OF SMALL INTERNAL CAMS

In model or experimental work on mechanisms such as are employed in typewriters and adding machines it is often necessary to produce say, twenty to sixty pieces, which must be interchangeable. Parts of this kind are frequently designed with small irregular shaped openings which serve as internal cams. The profile of these openings could, of course, be kept uniform by employing accurate dies, but where only a small number of parts is required the making of suitable dies would be too expensive. The following method of finishing cam profiles in duplicate parts is simple and accurate. Various adaptations of the method for milling curved surfaces, irregular slots, etc., may be employed to advantage.

The work shown at *A* in the illustration is made from rolled stock, ⅛ inch thick. Counterbores are first employed in order to remove most of the stock from the slot. The profile is then finished by attaching an accurate casehardened model or templet *B* to the lever *C* by means of screws *D* and *E*. These screws also pass through holes in the work, which is secured to the opposite side of lever *C*. The screws are made a tight fit in the three parts, which they hold together so that the parts are kept in proper alignment.

Two end-mills are used for the job, the teeth of one being ground a few thousandths inch smaller than the shank, while the other is ground straight; that is, the shank is ground to exactly the same diameter as the cutting part. The radius of the cutter is, of course, smaller than any radius in the profile of the opening to be machined. The smaller cutter is used to rough out all the pieces. This leaves, say, 0.004 inch at each side of the slot to be removed with the straight or finishing cutter. The templet bears on the shank of the cutters. The milling machine is fed with one hand, while the other hand holds the lever *C* which is raised or lowered so that the cutter will follow the outline of the templet. The profile of the work is thus quickly machined to exactly duplicate that of the templet.



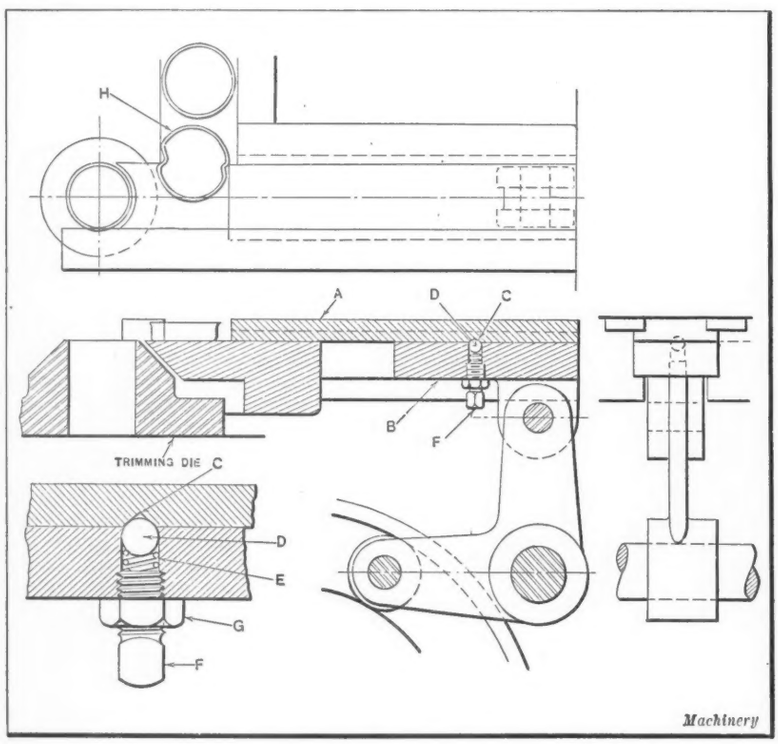
Milling Machine Set-up for milling Internal Cams

Detroit, Mich. CHARLES S. CULVER

SLIP DRIVE FOR PRESS FEED-SLIDE

The jamming of work in the feed-slide of an automatically fed press delays production and often causes considerable trouble. If the slide is positively driven, some part of the press or feeding mechanism is usually broken. A "slip-driven" slide designed to prevent trouble of this nature is shown in the accompanying illustration. This drive was applied to a trimming press which had been subject to frequent breakage due to the jamming of work in the regular feed-slide. The slip-driven slide effectively eliminated all breakage due to jamming, and the clicking noise made by the device when a piece of work was caught served as a signal to attract the operator's attention.

The feed-slide is made up of two parts, namely, the upper slide *A* and the lower slide *B*. A hole was drilled and tapped in the lower slide, as shown in the enlarged view in the lower left-hand corner of the illustration, and the upper slide was countersunk at *C*, the hole through the lower slide, being used as a means of locating or guiding the countersink. The ball *D* was placed in the hole in the lower slide, and backed up with a compression spring *E* and an adjusting screw *F*. When the required pressure has been exerted on ball *D* by the proper adjustment of screw *F*, lock-nut *G* is tightened, thus securing the adjustment. If the work being fed into the die becomes jammed, as shown at *H*, the upper part *A* of the slide stops, while the lower part *B* continues its forward movement, the ball *D* being depressed. On the return stroke the ball snaps back into the countersunk



Slip Driving Device for Press Feed-slide

cavity *C* in the upper slide, and unless the slide is cleared it will snap out again on the forward stroke. This makes the clicking sound that attracts the operator's attention. As the machine on which this device was used operated at a speed of over 100 revolutions per minute, the increase in production and the saving in expense for repairs resulting from the use of the slip drive feature can readily be appreciated.

Brooklyn, N. Y. S. A. McDONALD

COPPERING STEEL WIRE PARTS

A certain manufacturer who uses quantities of wire springs has adopted a simple method in connection with copper-plating the wire. The springs are made of steel wire which is not furnished the manufacturer copper-coated, on account of the abrasion that would be caused by the forming machines. After the springs come from the forming machines, they are dumped into a tumbling barrel of the upright type. A quantity of fine, clean, white sand is also put in the barrel, which is revolved for thirty-five minutes. The sand removes all oil from the springs, and prepares a good surface for the copper solution to attack. Following the plating, the springs are put into another barrel where they are cleaned and polished with sawdust. This cleaning and polishing requires but a few minutes. This process gives satisfactory results, and it is simple and inexpensive.

Middletown, N. Y. DONALD A. HAMPSON

DETERMINING THE DIAMETER AT THE END OF A TAPERED ROD

In July MACHINERY, page 910, there appeared an article entitled "Determining the Diameter at the End of a Tapered Rod." The solution of the problem as contained in that article does not appear to be correct. Apparently it is assumed that *N* (marked *N'* in the accompanying diagram) is the same as the other dimension marked *N* in the diagram previously published. If this assumption is incorrect, then the problem cannot be solved by the method described. The following solution is offered, in connection with which the accompanying exaggerated diagram may be referred to.

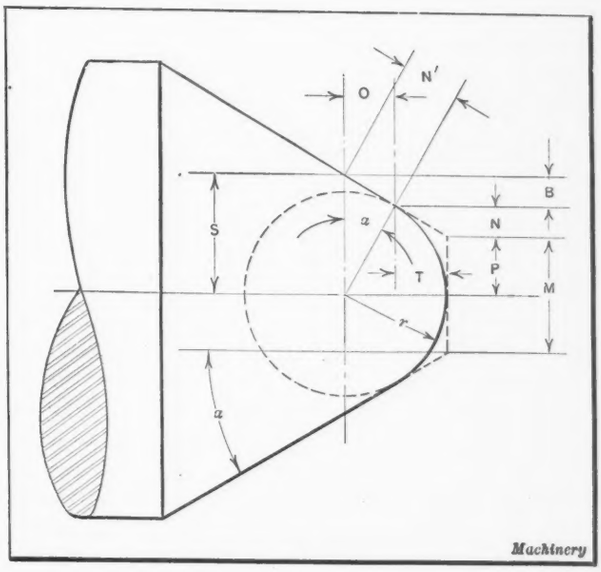


Diagram for finding the Diameter at the Tapered End of a Rod having a Rounded End

The known values are the angle of taper a at the end of the rod, and the radius r at the rounded end. It is required to find M, the original diameter at the end of the piece before rounding the end. By trigonometry,

$$N' = r \tan a; \quad S = \frac{r}{\cos a}$$

$$B = N' \sin a = (r \tan a) \sin a$$

$$O = N' \cos a = (r \tan a) \cos a$$

$$T = r - O = r - (r \tan a) \cos a$$

$$N = T \tan a = r - (r \tan a) \cos a \tan a$$

$$P = S - (B + N)$$

Substituting in the above equation, we have

$$P = \frac{r}{\cos a} - [(r \tan a) \sin a] + [r - (r \tan a) \cos a \tan a]$$

$$= \frac{r}{\cos a} - (r \tan a \sin a) + (r - r \tan a \sin a)$$

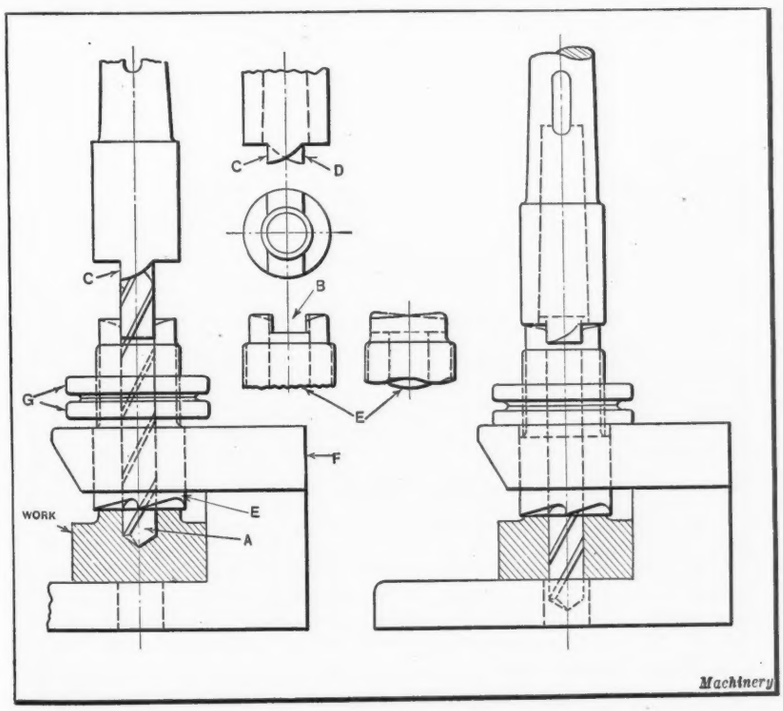
$$= \frac{r}{\cos a} - 2r \tan a \sin a + r$$

$$= r\left(\frac{1}{\cos a} - 2 \tan a \sin a + 1\right)$$

Then,

$$M = 2r\left(\frac{1}{\cos a} - 2 \tan a \sin a + 1\right)$$

Brooklyn, N. Y. CHARLES H. BUETHE



Combination Spot-facing Tool and Drill Bushing for drilling and facing in One Operation

COMBINATION SPOT-FACING TOOL AND DRILL BUSHING

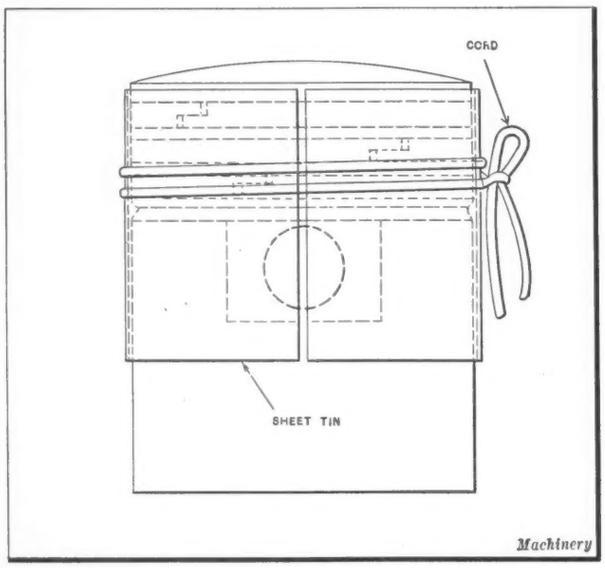
A combination spot-facing tool and drill bushing, such as here illustrated, will enable work ordinarily requiring two operations to be done in one operation, in half the time previously taken. The drill *A* passes through the spot-facing tool *E* which thus serves as a bushing. After the drilling operation has been completed, the operator continues the downward feed of the drill spindle, which results in the engagement of the two teeth *C* and *D* of the drill shank in a corresponding slot *B* in the upper end of the spot-facing tool *E*. Tool *E* is thus revolved in the jig plate *F* and further downward movement of the drilling machine spindle results in facing off the

work. The adjustable lock-nuts *G* coming in contact with the jig plate *F* serve as a stop. The view at the right of the illustration shows clearly the positions of the drill shank, the drill, and the spot-facing tool at the end of the downward feed.

Detroit, Mich. CHARLES S. CULVER

METHOD OF ASSEMBLING PISTONS IN CYLINDERS

The writer read with interest the description of a device for assembling pistons in cylinders which appeared on page 825 of June MACHINERY. The method described appears to be a very good one, the only criticism being that different sizes of pistons would require separate sleeves. This fact,



Piston ready for assembling in Cylinder

however, would hardly need to be considered except where a great variety of engines are assembled, as in garages or repair shops handling general repair work.

A method that the writer has found very satisfactory is as follows: Cut a piece of stiff tin such as used for canned goods to a length that will nearly but not quite encircle the piston. The width of this piece should be about two-thirds the height of the piston. The tin is wrapped carefully around the piston and rings after they have been cleaned and oiled ready to be assembled in the cylinder. A heavy cord is passed around the tin a couple of times and pulled tight in order to compress the rings. The string is tied in place with a single bow-knot as shown in the accompanying illustration.

As the piston is slid into the cylinder, the tin and string slide off at the lower end of the piston and are easily removed from the connecting-rod. This method keeps the piston clean and simplifies the work of assembling. The cost of the device is practically nil, and one piece of tin can be used for several sizes of pistons.

Hoosick, N. Y. WALTER CANTELO

SPREADING TOOL FOR SPLIT COTTER-PINS

Spreading split cotter-pins with a screwdriver is a slow method and one that is often responsible for minor injuries, due to the point of the screwdriver slipping from the work. In one plant the danger of injury from this source was eliminated and production increased by the use of a cotter-pin spreader made from a discarded belt punch. To adapt the belt punch for use as a cotter-pin spreader, the original cutter was removed and a V-shaped spreader inserted in its place. A small groove was also cut in the opposite jaw to prevent the cotter-pin from turning while the ends were being spread or opened.

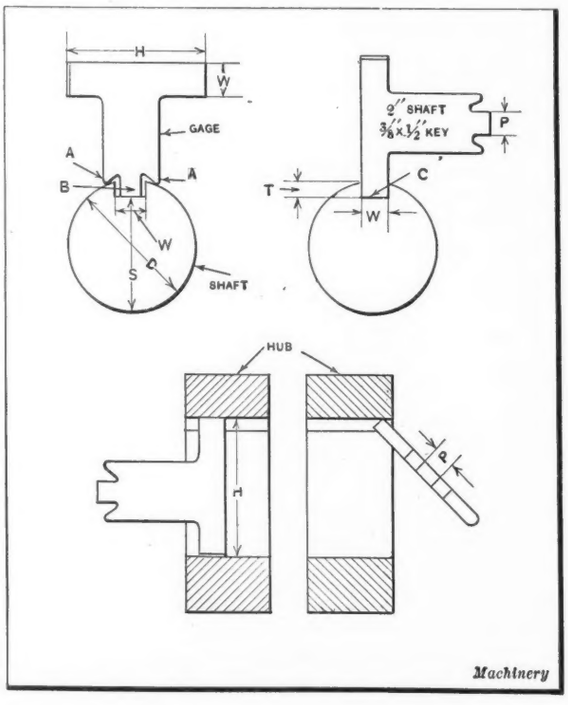
In the shop where the writer saw this cotter-pin spreader in use, the workman first inserted all the pins in the assembly, and then spread them with the tool. The time required for the spreading operation was thus cut to a fraction of that previously required, and a better job was obtained. A tool made as described is not limited to one size of pin, but can be used for a fairly wide range of sizes. The writer has seen the tool in use on pins ranging in size from ⅛ by ¾ inch to ¼ by 1 inch.

DeKalb, Ill. JOHN J. BORKENHAGEN

KEYWAY GAGE

When much keyway cutting in shafts and hubs is to be done on the shaper, a gage such as the one illustrated will be found useful. It is designed to gage the depth *T* and width *W* of the keyway in the shaft, and also the depth and width of the keyseat in the hub to which the shaft is to be keyed. In the two upper views, the gage is shown in position for gaging the depth and the width, respectively, of the shaft keyway. When the depth of the keyway is correct, as indicated in the view at the left, both ends *A* of the gage and the lower end of the gaging member *B* will be in contact with the work. The width *P* of the end *B* should be made slightly narrower than the width of the keyway.

For gaging the depth of the keyway in the hub, the dimension *H* should be such that the gage will be a good fit between the surface of the work at the bottom of the keyseat and the finished surface of the hole diametrically opposite when the keyseat is cut to the correct depth. The end *C* of the gage is used to gage the width of the keyway in both the shaft and the hub, as indicated in the illustration by



Gaging Depth of Keyway in Shaft and Hub

the upper and lower views at the right. The gage is made of flat steel, the thickness of which depends upon the size of the keyway. The dimensions required in making a gage for standard keyways for shafts of different sizes may be obtained by the use of the tables given in MACHINERY'S HANDBOOK on page 501.

Philadelphia, Pa. PAUL H. BYER

Questions and Answers on Practical Subjects

TOOLMAKER'S PROBLEM

H. B. G.—Referring to the accompanying illustration, will you please show how to find the diameter X of a plug P which will be tangent to the two finished surfaces AB and BG of the work and at the same time be tangent to a straightedge placed on the ground surface AF?

A.—The known elements are $AB = \frac{1}{2}$ inch and the angular measurement $11\frac{1}{2}$ degrees, as shown. Referring to the diagram,

$AB = \frac{1}{2}$ or 0.5 and $AB = AE + EB$

Also,

$EAD = 90$ deg. $+$ 11 deg. 30 min. $= 101$ deg. 30 min.

Therefore,

$CAE = \frac{1}{2}\ EAD = 50$ degrees 45 minutes

and

$ACE = 180$ deg. $-$ (90 deg. $+$ 50 deg. 45 min.)
$= 39$ deg. 15 min.

Also

$EBC = 45$ degrees and $ECB = 45$ degrees

Now

$AE = r \times \tan ACE$ and $EB = r \times \tan ECB$

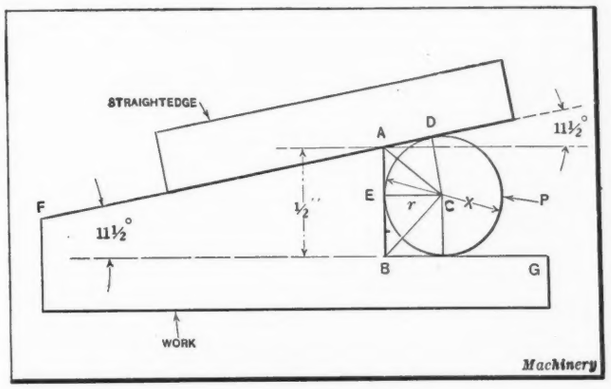


Diagram used in solving Toolmaker's Problem

As $AE + EB = AB$, we have

$AB = r \times \tan 45$ deg. $+ r \times \tan 39$ deg. 15 min.

or

$AB = r \times 1 + r \times \tan 39$ degrees 15 minutes
$= r\ (1 + \tan 39$ degrees 15 minutes)

Now as $AB = 0.5$ we have the equation,

$0.5 = r\ (1 + \tan 39$ degrees 15 minutes)

Hence

$$r = \frac{0.5}{1 + \tan 39 \text{ degrees } 15 \text{ minutes}}$$

As the tangent of 39 degrees 15 minutes $= 0.81703$, we have

$$r = \frac{0.5}{1.81703} = 0.27517 \text{ inch}$$

$X = 2r$ or 0.5503 inch

LOCAL CASEHARDENING

F. A. D.—We have some steel spindles that require casehardening only on two short bearing surfaces. What are the commercial methods of local hardening?

A.—There are several methods of local hardening. One is to paint the work with enamel where it is to be hardened, and to copper-plate the parts that are to be left soft. When the work is heated, the enamel burns away and the surface then absorbs the carbon. The copper coating, however, has no affinity for the carbon. Experiments have shown that a layer of electrolytically deposited copper, from 0.001 to 0.002 inch thick, is suitable. If desired, the entire surface can be copper-plated and the plating ground off where the hardening is to be done. Another method is to cover the parts that are to remain soft with a bushing or with ordinary tire tape; still another is to use fireclay for the protective covering.

"HOT TOP" IN STEEL MANUFACTURE

A. W. P.—What is "hot top" in steel manufacture?

A.—In the manufacture of steel, the molten metal from the crucible, converter, or electric furnace is poured into ingot molds. The impurities which float on the top of the molten metal are carried to the top of the mold, which is fashioned with a temporary "hot top" made of some refractory material. By this means the top of the ingot containing the impurities can be sheared off after the ingot is cold.

HARDENING DROP-FORGING DIES

J. R. de J.—In heat-treating shops, what is meant by "checking down"?

A.—Drop-forging and other similar dies which have irregularly shaped sections in which the metal is brought to a thin edge or ridge, present certain difficulties in quenching after heating, which are overcome by what is known as "checking" or "checking down." This consists simply of cooling the sections in which the metal is comparatively thin before the entire die-block is quenched. The preliminary cooling is done by applying wet waste or a piece of soap to the thin sections to bring the red-hot metal to a dark red color. This prevents cracking when the dies are quenched in water, and is common practice in heat-treating departments where work of this kind is regularly handled.

STEEL FOR BENCH LATHE SPINDLES

B. A. B.—Of what kind of steel are machine spindles such as bench lathe spindles usually made?

A.—The service required of bench lathe spindles—high wearing qualities and ability to withstand bending strains—indicates that a casehardened machine steel will give better results than will tool steel, and this material is therefore used by several bench lathe manufacturers. Properly heat-treated tool steel is also often used with good results, but the comparatively soft core of casehardened machine steel and its glass-hard surface makes machine steel particularly suitable for this use.

SIZE OF DROP-HAMMER

H. E. F.—What is the smallest drop-hammer recommended for use in making 6-inch flat wrench forgings?

A.—One is not liable to err if an over-size drop-hammer is selected, but it is dangerous to use a hammer which is not heavy enough to cause the dies to be filled in a few blows. Where many blows are required, the forging loses much of its heat, and consequently a higher initial heat is required with the attendant liability of ruining the surface of the die impression; or reheating becomes necessary and a correspondingly greater amount of time is required to complete the operation. If the forging is to be produced in single-impression dies, an 800- to 1000-pound board drop-hammer should be suitable; if double-impression dies are used, a 1500- or 2000-pound board drop-hammer will be required.

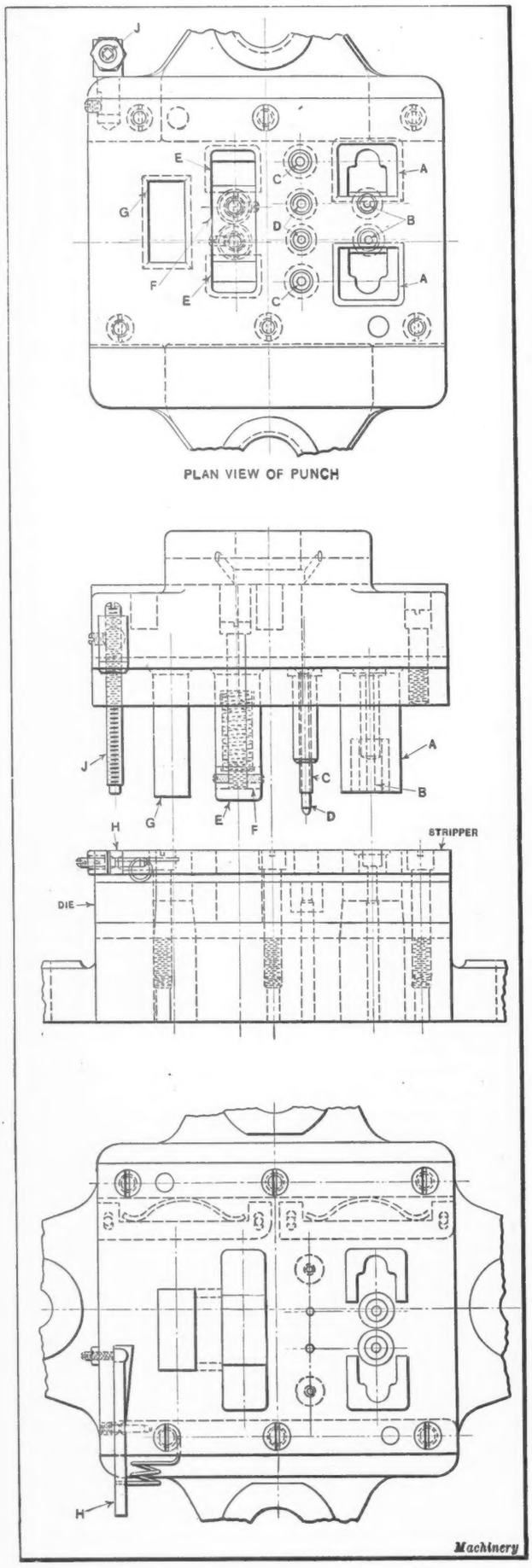


Fig. 1. Follow-die designed to produce the Bracket Support illustrated in Fig. 2

FOLLOW-DIE FOR PIERCING, BENDING AND BLANKING SMALL PARTS

By I. BERNARD BLACK

Dies of the follow type are rapidly gaining favor among manufacturers of small metal parts. In many instances, one die of this type is now used to pierce and blank work in one operation, which formerly required the use of several dies. Fig. 1 shows the general construction of the follow-die used to produce the part shown in the upper view of Fig. 2. This part is known as a bracket support, and is used in an electrical device, the nature of which requires that the part be of Norway iron. The stock is obtained in 10-foot lengths, 3 inches wide by 0.093 inch thick. It is fed to the press by means of a double roll feed. The speed of the press is 90 strokes a minute, and the gross production per hour is approximately 5000 finished pieces.

Referring to Fig. 2, it will be noted that the ends of the piece are bent at right angles to the central section. The provision of the bending punches *E*, Fig. 1, is a feature of particular interest in view of the fact that follow-dies are generally used for work that requires only piercing and blanking operations. The die lay-out is shown in Fig. 2. It will be noticed that this lay-out provides for four distinct stations. About 95 feet of stock is required for 1000 pieces.

At the first station the stock is blanked out at each side to form the rounded sections of the bent-up ends shown in the view of the finished piece. The part blanked out in this operation is shown in cross-section at *A*. The two holes *B* are also pierced at the first station. At the second station the two outside holes *C* are pierced, the stock being located by pilots *D* which enter the holes pierced in the first position. At the third station, the two ears or ends are bent down, and at the fourth station the piece is blanked out.

The construction of the punch and die is shown in Fig. 1. In the lower view is a plan of the die, and directly above is an elevation view of both punch and die. Part *A* is the punch which blanks out the part of the stock indicated by the cross-section *A* in the lower view of Fig. 2. Punches *B*

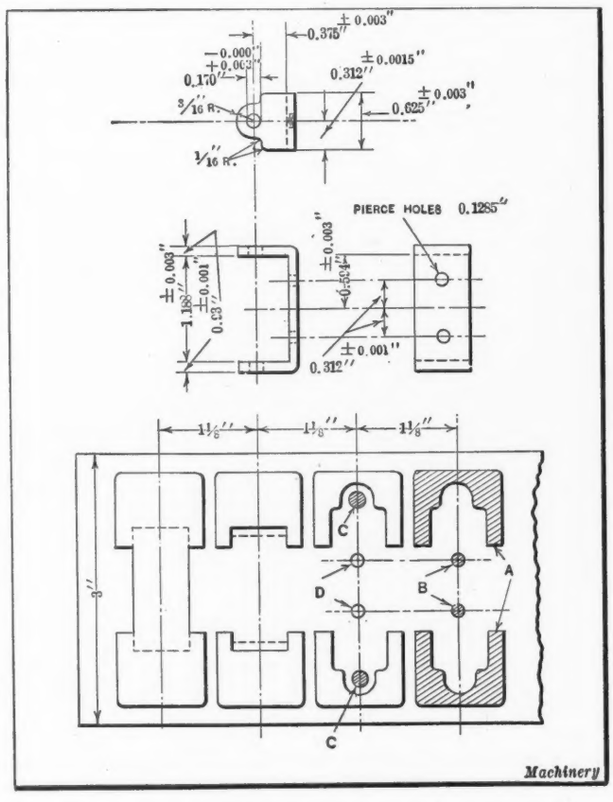


Fig. 2. Bracket Support and Lay-out of Die by which it is blanked, pierced, and bent

pierce the two central holes, the holes in the ends of the stock being punched in the second position by punches *C*. In this position the stock is located by pilots *D* which enter the central holes. The punches *E* that bend down the ends or ears are provided with steps designed to strike the outer points of the ears before the bending operation actually begins. It will be noted that a spring-actuated pad *F* is provided in the third position. This pad prevents the metal from being drawn or pulled to one side, and thus assists in obtaining a clean bend. The pieces fall through the die into a receptacle as they are blanked by punch *G*. A stop *H* locates the work after each feeding movement. The trip *J* which actuates stop *H* is mounted in a block attached to the punch-head.

* * *

BUFFING AND POLISHING RADIO PARTS

Nearly all the brass fastenings on radio instruments, such as springs, crystal cups, and parts used in crystal mounting, are nickel-plated and are polished before and buffed after being plated. Such parts require a bright nickel-plated finish. One of the buffing operations illustrated is finishing a DeForest crystal cup; this is being done on the farther wheel. These brass cups, after being polished and nickel-plated, are buffed, as shown, on sewed cotton buffs to which Vienna lime is frequently applied. The cups are slipped over a plain holder, like a shouldered spindle, which is also used in the polishing operation preceding nickel-plating.

Buffing a Bezel Ring

The other operation shown is buffing a bezel ring which forms a peek-hole in a receiving set panel. The ring is similar in design to a dial gage case, and is also nickel-plated. The wheel is frequently dressed with a lime composition in cake form, the commercial name of which is "Acme White."

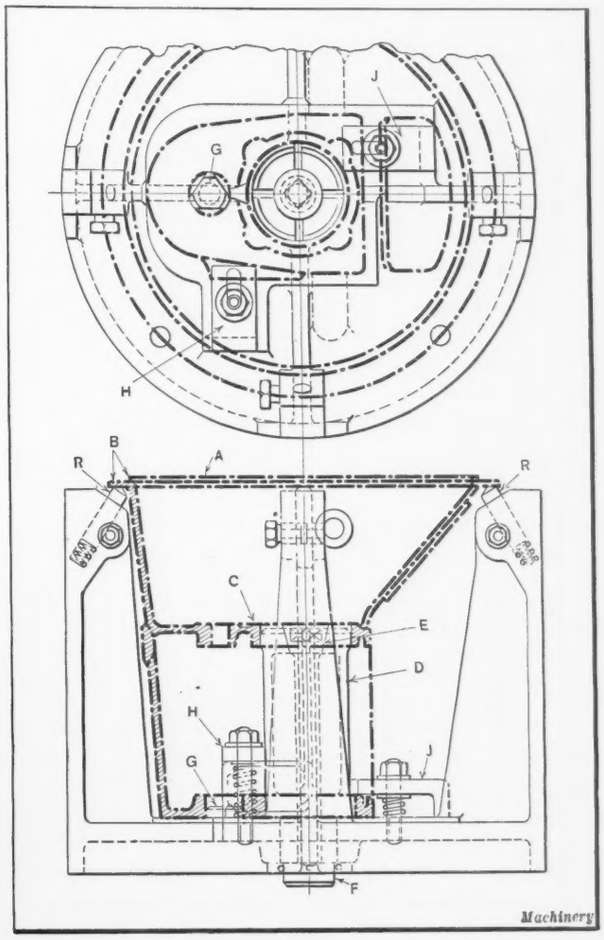
Buffing a Crystal Cup and a Bezel Ring used on Radio Instruments

All the buffs used in the buffing of these parts are made from sewed cotton plies, and have a soft open face which does not destroy the contour of the work, most of which is small. In order to obtain the best results, such work should be pressed into the face of the wheel while it is being buffed, and a wheel of sufficient flexibility on the face must be used to insure that the contour of the work will not be changed or destroyed.

FIXTURE FOR FACING AND TURNING TRANSMISSION CASE FLANGE

By WILLIAM OWEN

The fixture illustrated was designed for use on a 36-inch Bullard vertical boring machine, to hold the transmission case *A*, shown in dot-and-dash lines, while turning the surfaces *B* and the front bearing retainer face *C*. The body of the fixture is of rigid construction. It carries one large expanding plug *D*, which is actuated by the taper screw *E*. Screw *E* extends through the bottom of plug *D*. The plug *F* centers the fixture on the machine table.



Fixture used in turning and facing Transmission Case Flange

The three-point plug *G* holds the case from turning and locates it in the correct position for clamping. In loading the fixture, the case is slipped down over the large plug *D* and the small plug *G*. The clamps *H* and *J* are then brought into action, pulling the rear face of the case down tight on the fixture, after which the plug *D* is expanded by screw *E*. The four spring stops *R* are released and locked so as to hold the flange rigid under the cutting strain. This fixture is accurate, and can be easily loaded and unloaded. It has given excellent results when used for work done on a production basis.

* * *

A comprehensive course in employment management will become one of the regular features of the Technical Institute of Charlottenburg, Germany, beginning this fall. This course will cover methods for testing the suitability of apprentices and workers for the trade or occupation in which they wish to engage. It will also deal with time and motion study, taking into account both psychological and technical facts, and will cover all developments that have been made during recent years in regard to what might be termed scientific management in its broader sense.

Standardization of T-Slots

By H. CADWALLADER, Jr., President, Standard Shop Equipment Co., Inc., Philadelphia, Pa.

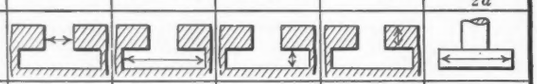
DESIGNERS of machine tools and special machinery often find difficulties in the designing of so simple a detail as a T-slot. This is due to the lack of uniform data obtainable from the experience of others, combined with the practical considerations that are likely to vary with each problem of design. The usual point of view has been to consider this method only from the standpoint of the particular machine involved. This lack of standardization causes considerable annoyance when endeavoring to set a precedent for future designs, especially when several machines may be found in the same shop with slots of different dimensions, though supposedly for the same diameter bolt. However, something has been done to correct this prevalent condition in the past, and it looks now as though the entire problem is in the proper hands for its permanent solution.

This year (1922) the National Machine Tool Builders Association at its convention held in Atlantic City, appointed committees in the lathe, planer, boring mill, drilling machine, and milling machine divisions, to report on the standardization of T-slots. These committees will work with the American Society of Mechanical Engineers and their findings will be governed by the question of practicability as applied both to design and application in the shop. Reports of these committees will have widespread distribution and should go far toward solving the problem. Ernest F. DuBrul, general manager of the association, brought the matter before the convention and called attention to the progress being made along kindred lines by the English Machine Tool Builders Association.

The Pioneer Work of Taylor and Barth

It may be well to consider the high spots of the past. The late Frederick W. Taylor saw the need of standardization of T-slots, but was limited in this work to the shops where

TABLE 1. PROPORTIONS OF T-SLOTS AND BOLT HEADS BASED ON EARLY BARTH FORMULAS

	$d+1/32$	$2\frac{1}{16}d+\frac{1}{8}$	$1\frac{1}{16}d+\frac{1}{16}$	$H=1\frac{1}{2}d$	BOLT HEAD = $2d$
BOLT DIAMETER d					
½	17/32	1 5/32	1 1/32	¾	1
⅝	21/32	1 13/32	1 5/32	15/16	1¼
¾	25/32	1 11/16	1⅛	1⅛	1½
⅞	29/32	1 15/16	1	1 5/16	1¾
1	1 1/32	2 3/16	1⅛	1½	2

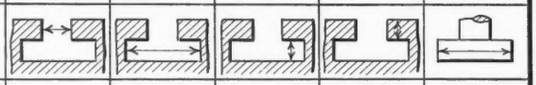
Machinery

the Taylor system of scientific management was being installed. He made no attempt at a world-wide standard, but worked rather to establish a standard for a given plant with the idea of curtailing to a minimum the number of changes necessary in that plant to aid in bringing about efficient production. Perhaps that method of inaugurating a general standardization was the best, because with it there was a chance to overcome its difficulties and to prove its possibilities. In those early days many machine tool builders actually had no slot standards of their own. Two or three types of tools built by the same manufacturer would have different sized slots for the same diameter bolt. Since then the number of machines and plants have multiplied so fast that general concentrated action is now imperative.

Carl G. Barth was probably among the first to give this subject detailed study and investigation. Much credit is due Mr. Barth for his work on this subject, as it indicated to the users of machine tools the importance of consistency in T-slot sizes. Mr. Barth's early formulas, worked out at the Philadelphia plant of the Link-Belt Engineering Co. in 1903, are given in Table 1. Quite a number of firms, in ordering machine tools, specify that such tools be furnished with T-slots proportioned according to their T-slot standards But this practice puts the "cart before the horse," since the buyers specify a standard instead of the manufacturers.

In designing T-slots, the amount of metal surrounding

TABLE 2. PROPORTIONS OF T-SLOTS AND BOLT HEADS BASED ON LATER BARTH FORMULAS

	d	$1\frac{3}{4}d+\frac{5}{32}$	$\frac{5}{8}d+\frac{7}{64}$	$H=1\frac{1}{2}d$	BOLT HEAD = $1\frac{5}{8}d+\frac{9}{64}$
BOLT DIAMETER d					
½	½	1 1/32	27/64	¾	57/64
⅝	⅝	1¼	½	15/16	1 3/32
¾	¾	1 15/32	37/64	1⅛	1 15/64
⅞	⅞	1 11/16	21/32	1 5/16	1½
1	1	1 29/32	47/64	1½	1 45/64

Machinery

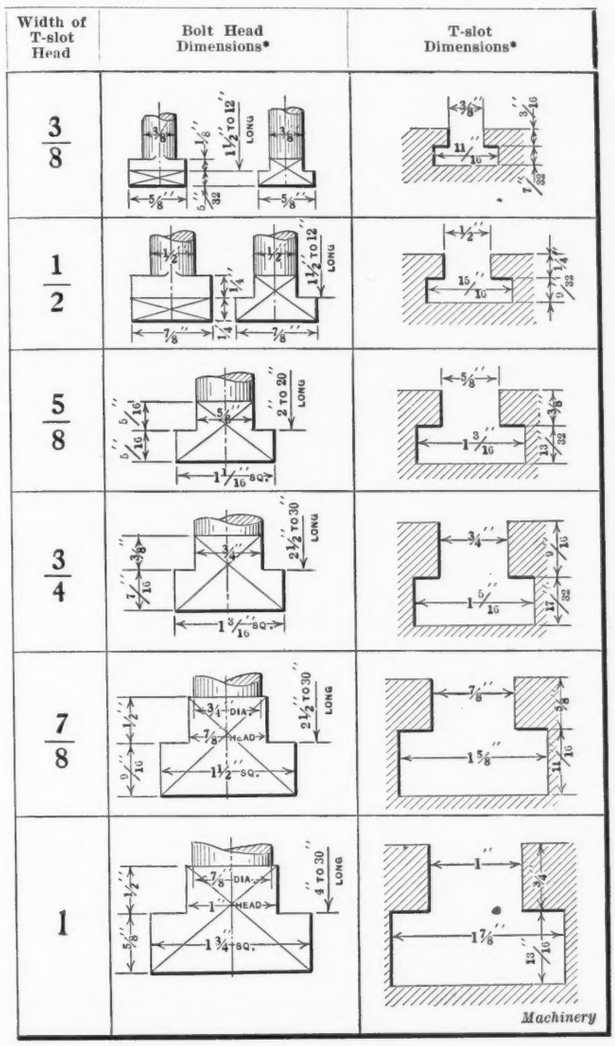
the slot is a practical point to consider. For dimension H (Table 1) on a machine such as a planer, where it is necessary to surface or true the machine table occasionally, it may be advisable to provide extra metal to allow for refinishing. This is particularly true of the heavier types of machine tools where heavy castings are liable to mutilate the table. The T-slot tables given on page 1087 of MACHINERY'S HANDBOOK are a good standard and represent dimensions used by a large proportion of machine tool builders. They have done much toward preventing new designs from going to extremes on certain dimensions and may be wisely followed where there are no available data on standards in the field in which the machine is being designed. Space does not permit giving all of the data available, but a more recent table of Mr. Barth's is well worth including (see Table 2).

Standards that are Widely Used

The Standard Shop Equipment Co., Inc. has adopted standards for T-slot bolts which are made to suit a large percentage of the machine tools now on the market (see Table 3). The relation of bolt head and slot sizes is such that there is an allowance of 1/16 inch on the width for the smaller bolts and ⅛ inch for the larger sizes. This allowance is chip space. There is also a proportionate chip clearance for the thickness of the bolt head. These bolt standards were adopted after much collating of information on present designs and sizes and are suitable for about 80 per cent of the machine tools manufactured. The amount that the bolt head is located below the surface of the machine table (dimension H) must be a more or less variable dimension because it must be greater in cases where the working surface must be machined occasionally to true it up.

Some common faults of present slot designs might be mentioned. Aside from the lack of standardization, most slots

TABLE 3. PROPORTIONS OF T-SLOT BOLTS AND T-SLOTS CONFORMING TO A COMMERCIAL STANDARD



*The bolts listed are commercial sizes and the T-slots conform, either exactly or closely, to the proportions adopted by a large percentage of the machine tool builders.

are too large in the "width of head" dimension. The strength of the bolt head is its shearing strength at the shank; hence the wide head adds nothing to the strength of the bolt, and if extreme it causes the overhanging metal in the slot to break on account of the strain on the bolt causing the metal to be stressed more (as in a cantilever) with the increase in leverage. Bolt manufacturers claim that too much metal in the bolt head only tends to weaken the "head shearing" value because of the excessive distortion of the metal in forging the head.

It is believed that the committees appointed by the engineering societies will settle upon a standard for bolts with as small a width of head section as is practicable, giving due consideration to present slot dimensions and without making changes that are too radical and that will affect the majority of manufacturers. The committees' problem will not be to create an additional standard but to correct differences in those local standards now in use.

* * *

What is quoted as a rivet-cutting record was recently established in the tearing down of a standard freight car under ordinary yard conditions, when an operator recently cut out 1038 rivets in two hours and forty-six minutes. Heavy scale and rust, it is stated, made the cutting difficult, and it was necessary to work inside, outside, and under the car. In performing the work 384 cubic feet of oxygen and 83 cubic feet of acetylene were used.

INDUSTRIAL STANDARDIZATION IN GERMANY

The great strides now being made in Germany toward industrial standardization are referred to by Oscar R. Wikander, an engineer who has just returned from Germany where he represented the American Engineering Standards Committee in conferences concerning the international standardization of ball bearings. Mr. Wikander states that it appears that one of the main reasons why forward-looking Germans are forcing their standardization work to the extent at present being done is because they want to introduce German standards in other importing countries. Holland, Switzerland, Austria, and Sweden, and many other European countries follow the German lead very closely, and German deliveries of goods to France will no doubt be made, as far as possible, according to German standards, thereby introducing them into that country.

The German engineering standards committee, known as the "Normenausschuss," has already issued several hundred sheets of approved standards and about twice as many have been published as proposed standards. This enormous output of the German organization has led many to believe that it was merely a factory producing "paper standards," and that its work was not to be taken too seriously. Mr. Wikander states that a personal investigation convinced him that this is not the case and that the great output of standards is due to the enormous efforts put forth and to the enthusiasm of a great majority of interested parties. The reason for this enthusiasm is the general recognition of the great economic value of standardization and the very generally accepted opinion that a standardized industry will be one of the strongest factors in Germany's struggle for economic and financial reconstruction.

As an example of cooperation and standardization in manufacturing, it may be mentioned that a syndicate of one Swedish and nineteen German manufacturers are executing an order for 700 locomotives for Russia, all of the same design, every part being made interchangeable with the corresponding part in the other engines. One of these locomotives was assembled from parts made in twenty different shops with no more difficulty than a locomotive built complete in one shop. In case of future orders, it is expected that these will require interchangeability with the engines already built, and it is easy to see how the German manufacturers of locomotives will have a great advantage over those of other nations when competing on the basis of such specifications.

It has often been believed that the German standardization committee is autocratic in its methods and that it is not in close contact with the industries, but this is an erroneous opinion. The actual work of establishing standards is left to experts who are recognized leaders in the various industries, and the staff of the standardization committee merely coordinates and directs the work of the various committees. Many of the larger German manufacturers have standards departments of their own, with a number of engineers and draftsmen working permanently on national standards. Because of this cooperative spirit the German standards committee has come to play a more important role in the industrial life of the nation than was originally expected, and manufacturers now write to the committee for advice upon questions of the most intricate nature.

In his report to the American Engineering Standards Committee, Mr. Wikander concludes by saying that he hopes that American manufacturers will realize the enormous economic importance of industrial standardization and take steps to eliminate waste through duplication, through lack of system and coordination in sizes, and through failure to establish interchangeability of products where such interchangeability is desirable.

The Machine-building Industries

IF the adverse influence of the railroad and coal strikes had not so materially affected conditions, there is every reason to believe that at this time a general industrial improvement could have been recorded. In practically all industries, including that of machine tools, business increased considerably during the spring months, and this improvement was quite definite up to the end of June. The rate of progress slowed down somewhat during the summer months, which is usual, and the uncertainty in all industries due to the coal and railroad strikes has also made itself felt in its reaction upon the machine tool industry. Business is reported to be somewhat more active in Ohio and the middle western states than in the East; and in spite of the temporary falling off it is considerably better throughout the country than in 1921. There is every indication that as soon as the strikes are definitely settled, there will be a marked improvement in the industries in general, including the machine tool and the machine-building industries as a whole.

In the spring, railroad buying had begun to a considerable extent and lists were being prepared by railroad shop executives that promised a fair amount of business during the remainder of the year. Then came the coal strike which slowed things down materially, followed by the railroad strike which put a still heavier brake upon the wheels of industrial improvements. The railroads have again been set back, and their ability to buy and thus greatly help maintain other industries in active condition has been impaired.

Advanced prices for machine tools are to be expected. As mentioned in August MACHINERY, some manufacturers have already advanced prices while others are contemplating an increase within the near future. The coal strike has considerably advanced the prices of all kinds of materials used in machine tool building, and this will naturally be reflected in the price changes; but more important is the fact that prices were reduced during the last eighteen months to levels often below cost of production. Keen competition and the efforts to unload large stocks were responsible for this. Now that demand is better, prices will return to a normal level.

The Iron and Steel Industry

Prospects in the machine tool industry can always be judged with fair certainty from current conditions in the iron and steel industry. Business steadily improved in this basic field during the first six months of the year, and normal conditions were close at hand when the effect of the strikes began to be felt. These effects are now quite pronounced. The price of coke is rising rapidly, and the scarcity of coal has forced may shut-downs of blast furnaces and mills. The railroad strike during the last two months seems to have affected the steel industry more than the coal strike did during a period of five months. When coal could be moved, there was enough coming from non-union mines to supply the most urgent needs, but the railroad strike has placed a different aspect on the whole situation. The mills have fallen behind in orders and deliveries are slow. The prices of all iron and steel products are continuing to increase. By the middle of August, at least fifty blast furnaces had been banked or blown out during the preceding four weeks due to coal shortage, and it is expected that there will be many more shut-downs. Pig iron is from $8 to $9 above the price of a year ago. Nevertheless, the United States Steel Corporation early in August operated at 70 per cent capacity, and a speedy settlement of the strikes might make it possible to nearly maintain this rate.

The situation is the more deplorable since without strikes the immediate outlook undoubtedly would have been bright and employment in all industries more general with the condition of labor as a whole greatly improved. The strikes have retarded the industrial readjustment that was taking place, and the loss of workers' wages and of railroad and mine operators' revenue are but a small part of the total loss the country as a whole, including labor of all classes, is sustaining through the slowing down of the industries.

The Automobile Industry

The only industry that in spite of all difficulties seems to hold its own is the automobile industry. It is true that the strikes have affected production in the Detroit district and that August will show a decrease from the high records of the last four months, but this would have taken place to some extent anyway on account of the falling off of the seasonal demand. To some points, cars can no longer be shipped by rail because of freight congestion. They are shipped by boat as far as possible from Detroit, and are then driven to their destinations.

Complete figures of the Department of Commerce for the production of passenger cars show that 261,963 were produced in June, in addition to 25,912 trucks. This was an increase of about 32,000 cars and trucks over May, the increase being due both to greater domestic demand and greater exports. During July operations were at about 90 per cent of the June schedules, except that the Ford plants did not curtail production. The output in June of the Ford plants was nearly 142,000 cars, nearly equalled in July, and with August schedules also maintained.

It is estimated that there are now 10,863,000 cars in use in this country—an increase of 1,428,000 in the last year. There have been announcements of new models from nearly all the companies, with further price reductions. The indications are that the slowing down in sales for the next six months will be less than usual at this season of the year.

General Industrial Conditions

The agricultural machinery and implement business which was very seriously affected by the business depression from which we are emerging, shows a marked improvement. Production, particularly of threshing machines, has been increasing and employment in the entire agricultural machinery and implement industry shows an increase during recent months.

Pump manufacturers state that their business is much better than it was a year ago, and that production has been increasing at a satisfactory rate. A steady reduction of the number of people out of work was reported up to the end of June. There is a scarcity of labor in the skilled trades, and in some of the smaller towns the point has now been reached where there is no unemployment.

"If a satisfactory settlement of the present labor difficulties can be reached in the near future," says the Department of Commerce, "there is every reason to believe that business will continue on its present level or even increase in volume. The failure to re-establish European economic equilibrium may continue to limit our foreign trade in that direction, but domestic conditions as well as those in many other parts of the world are favorable to further expansion."

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

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Landis Roll Grinding Machine

MILL rolls of all types used in hot- or cold-rolling may be finished in a heavy-duty roll grinding machine built in a number of sizes by the Landis Tool Co., Waynesboro, Pa. The machine illustrated has a swing of 40 inches and takes rolls up to 14 feet in length. Other standard sizes have a swing of 20 or 30 inches, and all sizes are built to any required length. The machine is driven by three motors, one of which is direct-connected to the headstock for driving the work. The second motor drives the wheel-head, being mounted on a carriage which travels on a track running along the rear of the machine. The third motor drives the impeller pump which supplies water to the grinding wheel. The work-driving and wheel-head motors are both of 25 horsepower capacity, and the pump motor of 5 horsepower. In addition, a small reversible motor feeds the wheel-head toward and away from the work. The entire machine, both mechanically and electrically, is controlled from the operating platform on the wheel-head carriage. Starting and stopping of the motors is accomplished by means of push-button switches.

A special feature of the Landis roll grinding machine is an attachment which provides for grinding rolls concave, convex, tapered, or straight. The machine is self-contained, separate motors being employed for driving the different units. The movements of all machine members are controlled through handwheels, levers, and push-button switches on the operator's platform. This platform moves with the wheel-head carriage as it travels along the rear of the machine.

Construction of the Headstock and Tailstock

The relative positions of the headstock and its motor may be observed in Fig. 1. The headstock casting is bolted to the bed and is provided on the under side with teeth that are engaged by a ratchet in the direction of the thrust, thus eliminating endwise movement. Two speeds are furnished by the gears in the headstock which are thrown

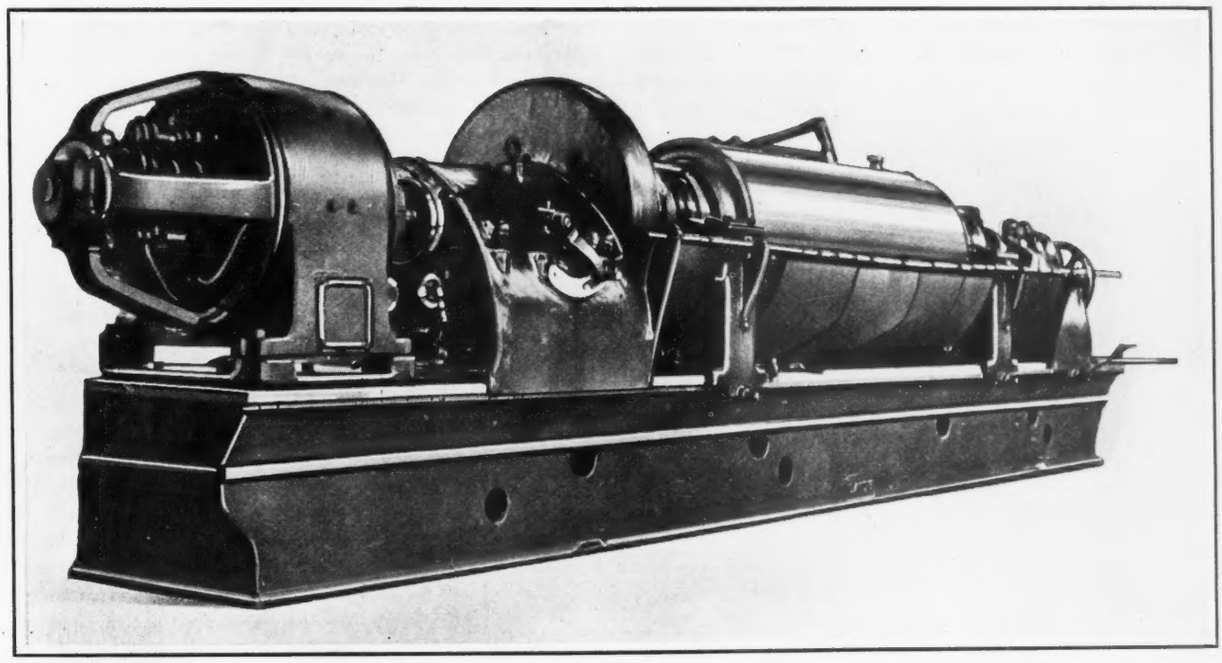


Fig. 1. Landis Heavy-duty Roll Grinding Machine which is controlled entirely from an Operator's Platform on the Wheel-head Carriage

into and out of engagement by means of the handle on the front of the headstock. Additional speed changes are secured from the motor, which is of the variable-speed type. The equalizing drive on former Landis roll grinding machines is also furnished on this machine. By this drive power is transmitted directly from the motor to a flexible coupling keyed to a shaft in the headstock. This shaft, in turn, is geared to the faceplate.

The tailstock is also held to the bed by means of clamping bolts, and a ratchet and pawl take up the thrust. A latch prevents the pawl from disengaging while the machine is in operation. The shaft on which this pawl is mounted passes through the tailstock and provides a means of lifting the pawl when it is desired to move the tailstock along the bed. This positioning of the tailstock is accomplished through a pinion that engages a rack on the front of the bed. The tailstock spindle is advanced and withdrawn by rotating the end handwheel seen in Fig. 2, which functions through a pair of gears. The handle on top of the tailstock is employed to lock the spindle in position after making a setting.

The roll supports are of a two-bearing type which permits grinding of the journals without changing the position of the roll. With this arrangement concentricity of the body and the journals is assured. This concentricity is particularly essential with rolls used in cold-rolling thin metal to close limits. The bearing block in the roll supports is made adjustable so as to accommodate journals of different diameters. One of the roll supports is shown disassembled in Fig. 3.

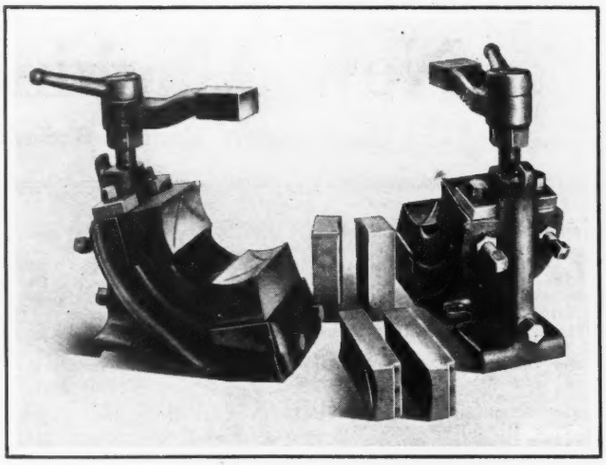


Fig. 3. Support in which the Journals of a Roll rest during an Operation

Wheel-head Features

The operating platform on the wheel-head is so located that the operator at all times has a clear view of the point of contact between the grinding wheel and the work. The wheel-spindle is driven from its motor by a belt which passes over three idler pulleys. One of these, strictly speaking, is not an idler but actually the driving pulley for the mechanism which traverses the wheel-head. This pulley furnishes power from its shaft, through a spider coupling, to the driving shaft of the traversing mechanism. This driving shaft has a worm mounted on it for revolving a worm-wheel on a shaft arranged crosswise of the machine. From the worm-wheel shaft the drive is transmitted through bevel gears to the vertical shaft of a gear-case, a reversing clutch being provided on the worm-wheel shaft. The gear-case provides three speeds, and this number may be doubled by means of back-gears on the clutch shaft. At the lower end of the vertical gear-case shaft is a worm which drives a worm-wheel set at an angle with the longitudinal center line of the bed. On the opposite end of the worm-wheel shaft is mounted a worm which meshes directly with a rack at the rear of the bed. This mechanism serves to traverse the wheel-carriage back and forth past the work.

The wheel-carriage may also be moved by revolving the handwheel upon which the operator's hand is seen resting in Fig. 2. The handle beneath the handwheel is employed for throwing out the power clutch and for engaging the hand feed. The "spiral" below this handle is utilized for setting dogs which cause a reversal of the carriage movement at any desired point. By having a worm on the dogs and worm teeth on the spiral, it is possible to adjust the dogs very accurately. Two handles at the front of the operating platform control the traverse speeds, one of them being used for engaging and disengaging the back-gears, and the other, the gears in the gear-case. The wheel-head is fed by power toward the work and away from it, by a small reversible motor, as previously mentioned, which is operated by a switch that is close to a slow-motion handwheel. This handwheel is used to obtain a fine adjustment of the wheel-head.

A special feature of the machine is that it will grind rolls either concave, convex, straight, or tapered. This has been made possible by hinging the wheel-head on an auxiliary base that allows the wheel to be lifted to bring its center line above that of the work. This is accomplished by the manipulation of an eccentric shaft at the front of the wheel-head. The amount of concavity or convexity within a given length can be varied by means of simple gearing at the back of the machine, and this amount may easily be determined by reference to a chart that is furnished. This gearing is engaged and disengaged by a lever on the operating platform. Under typical operating conditions the machine illustrated has removed seven cubic inches of chilled iron per minute. The roll shown mounted on it weighed approximately 8 tons.

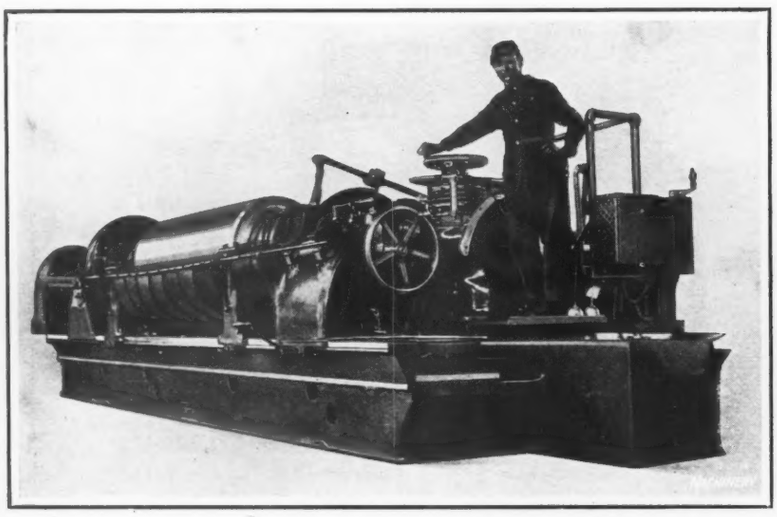
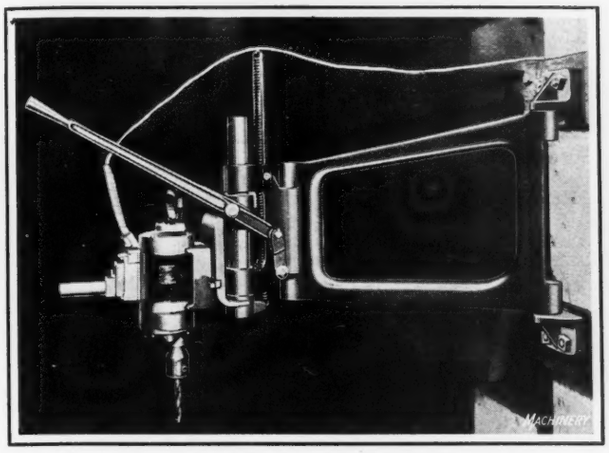


Fig. 2. View from the Tailstock End of the Roll Grinding Machine in which the Operator's Platform may also be seen

VAN DORN ELECTRIC RADIAL-ARM DRILL

A radial-arm drill intended primarily for use by millwrights and maintenance men, has been added to the line of products manufactured by the Van Dorn Electric Tool Co Cleveland, Ohio. It will be seen from the illustration that the equipment can be bolted to a wall or column by means of two pivot brackets. At the outer end of the main arm casting is another pivoted joint on which a short forearm swings. A portable electric drill is mounted on a sliding member at the



Van Dorn Millwrights' Radial-arm Drill

outer end of the forearm. This construction permits quick location of the drill when using the equipment.

The drill bracket or sliding member is raised and lowered by means of a long lever and a toggle-link mechanism. A secondary lifting arrangement is also provided in the form of a strong tension spring which is attached to the lower part of the drill bracket, and hung from an extension rod above the forearm. The drill can be quickly attached by simply unscrewing one handle and bolting the drill to an adapter plate on the forearm. The radial arm with the drill attached covers a radius of 31½ inches, and the auxiliary forearm provides a secondary radius of 10½ inches. The driving motor is of the universal type operating on either alternating or direct current. It is ventilated by means of an aluminum fan on the rotor shaft, and is equipped with ball bearings. A special drill chuck allows the use of drills up to ⅝ inch in diameter for drilling holes in iron and steel. The housing of the drill is made of aluminum and can be quickly disassembled for greasing or cleaning.

CLEVELAND AUTOMATIC DOUBLE-END THREADING MACHINE

Both ends of forged or rolled locomotive-boiler staybolts or similar parts may be simultaneously threaded in an automatic machine now being placed on the market by the Cleveland Automatic Machine Co., Cleveland, Ohio. With this machine the time required to thread a staybolt is only that necessary for threading the longer end. A magazine provides for continuous operation of the machine, which results in high production rates. Each staybolt is carried from the magazine, by means of a small vertical conveyor, down into line with the threading dies, where it is gripped for the operation. Threading both ends of the staybolt simultaneously necessitates gripping it at the center. The gripping jaws are of a floating design so that both staybolt ends may be aligned with the dies even if the part that is gripped is out of true. The ends may be over 1/16 inch out of true in the rough and still be threaded in line with each other.

The gripping jaws are composed of an upper half *A*, Fig. 3, and a lower half which is not visible. Both halves pivot on a stud, and are opened and closed by means of a toggle mechanism operated by lever *B*. This lever is controlled by cam *C*, Fig. 2, which functions through lever *D* and a connecting bar. Fig. 3 shows the gripping mechanism with the jaws just closed. The slot in lever *B* is enlarged at the lower end to give a slight free movement which allows the jaw slide to shift forward or backward and the jaws to oscillate. This constitutes the floating feature of the jaws previously referred to.

In setting up a job, a master staybolt or long thread gage is inserted in one of the die-heads, which is then closed upon it. Next, by means of a fine adjustment, the other die-head is brought to a position where it may also be closed upon the gage. In this manner the die-heads are so set that a continuous-lead thread will be produced on the staybolt ends. The lead-screw is mounted back of the die-spindles and is driven directly from the left-hand die-head spindle through gearing. The die-head slides *E* and *F*, Fig. 1, are controlled by the lead-screw during the cutting stroke, but when the desired length of thread has been cut, the die-heads are opened by contacting with stops at the front of the machine, and the lead-screw nuts are tripped open by cams. The slides are then returned by the action of cams on drums *G* and *H*, Fig. 2.

When the return stroke is nearly completed and the die-heads are just clear of the work, the jaws open and move backward, ejecting the finished staybolt, which drops into a pan. Another staybolt is then lowered from the magazine into a position in line with the die-heads. The opening of the jaws, the ejecting of the finished staybolt, and the withdrawal of the slide upon which the jaws are mounted to allow another staybolt to be lowered from the magazine, all occur during the backward movement of the toggle mechanism operated by lever *B*, Fig. 3, as previously mentioned. The forward movement of this toggle mechanism advances the slide with the jaws open until they are in position to close on the staybolt, at the same time seating the staybolt in V-blocks just in front of the die-heads and thus aligning the staybolt with them. The jaws are then closed on the staybolt, a heavy spring cushion allowing for slight variations in the diameter of the portion gripped.

The pulley at the left-hand end of the machine in Fig. 1 drives a shaft which extends through the inside of the bed to the right-hand end. The die-head spindles are driven from this shaft through gears at each end of the bed. This long horizontal shaft also drives through spiral gearing, a transverse shaft at the right-hand end of the machine which, in turn, transmits power to the camshaft at the rear. Change-gears under cover *J*, Fig. 2, regulate the operation

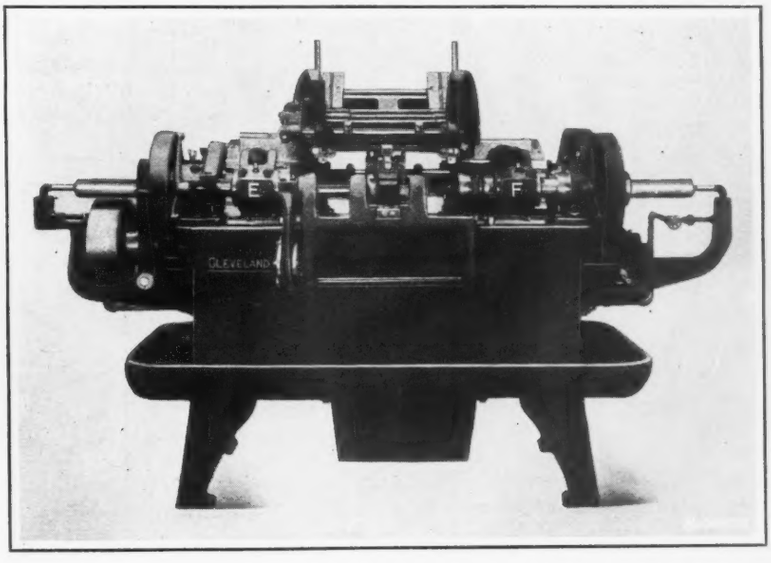


Fig. 1. Cleveland Automatic Double-end Threading Machine, which is especially designed for handling Locomotive-boiler Staybolts

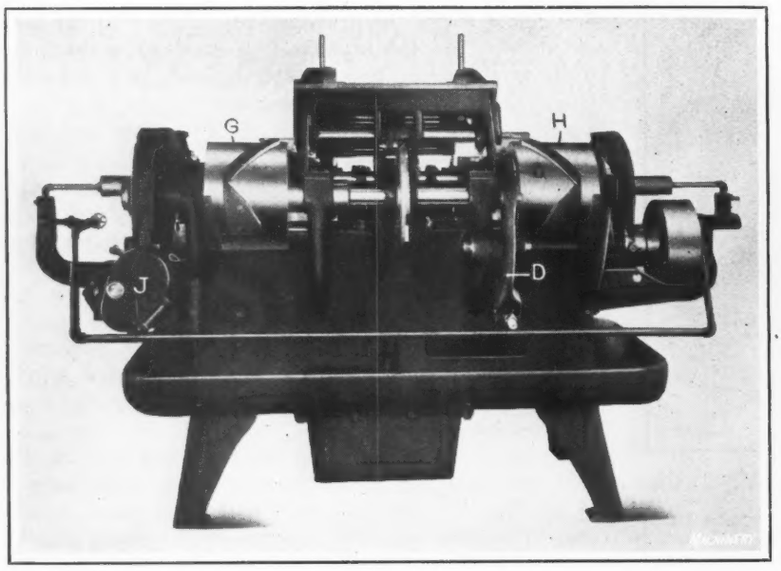


Fig. 2. Rear View of Cleveland Double-end Threading Machine, showing the Cam Drums for returning the Die-head Slides

of the camshaft to suit different lengths of threads. The machine is equipped with a safety pin which shears off when an attempt is made to machine staybolts that are too much out of shape. Cutting oil is pumped through both die-heads in a heavy stream to wash away chips, and cool and lubricate the chasers. The starting and stopping of the machine is controlled by a lever at the left-hand end which functions through a friction clutch. The die-head spindles can be quickly moved horizontally to locate them in the proper position when changing from one length of staybolt to another, and the magazine is also adjustable for this purpose.

The machine threads staybolts up to 1 5/16 inches in diameter and from 7 to 18 inches in length. The production time is from 35 to 60 seconds per staybolt, depending upon the diameter and length of the thread. One man can usually operate five of these machines, as the magazine requires filling only every forty to fifty-five minutes. Besides threading staybolts, this machine is also adapted for threading studs, pipe nipples, and tubing, and turning shaft ends. Such turning operations can be done by substituting the proper cutting tools in the die-head spindles and arranging the spindles for running at high speeds. Plain gripping jaws can also be furnished instead of the toggle design.

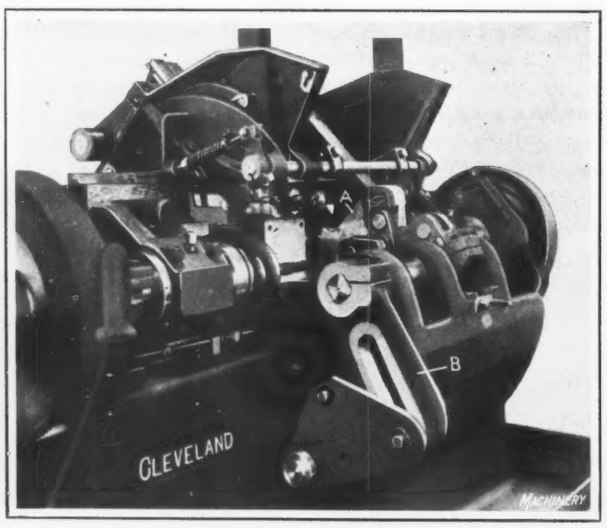


Fig. 3. Close-up View of Details at Front of Double-end Threading Machine

PRATT & WHITNEY "SUPER-MICROMETER"

Most workmen experienced in using micrometers on precision work can measure to within 0.0001 inch, assuming that an accurate micrometer is employed; nevertheless, variations in readings of from 0.0002 to 0.0004 inch are not uncommon. There are two chances for error; first, the micrometer, especially if owned by the workman and not checked periodically, may be slightly inaccurate. Second, the readings taken by different men are sure to vary more or less because of difference in contact pressure, vision, and judgment. In order to enable measurements within 0.0001 inch to be readily and repeatedly taken by different workmen without exercising particular care, the Pratt & Whitney Co., Hartford, Conn., has developed a "super-micrometer." It is intended for use in tool-rooms and machine shops, and accurate results are obtainable by men who have not previously used it.

From the general view of the "super-micrometer" shown in Fig. 1, it will be seen that the machine has a stationary micrometer headstock and a footstock which may be adjusted

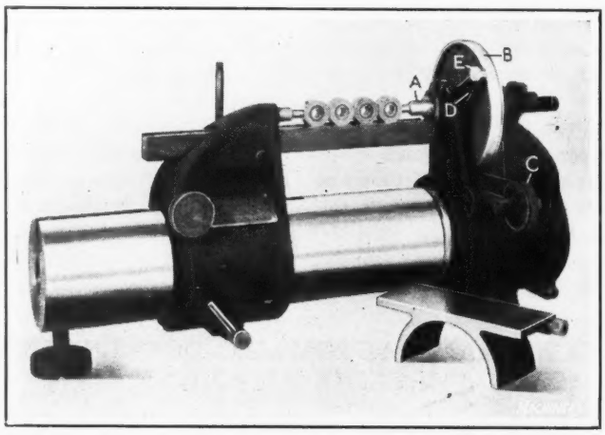


Fig. 1. Pratt & Whitney "Super-micrometer" designed for accurately measuring to 0.0001 Inch

along a rigid cylindrical bed to permit the measurement of lengths up to 8 inches. The micrometer headstock has a threaded measuring spindle *A* passing through a nut in the hub of the 5-inch graduated disk *B*, which is a duralumin forging. The settings are made by the use of standard inch-blocks, which are lapped by a modification of the Hoke process and are stated to be accurate within five

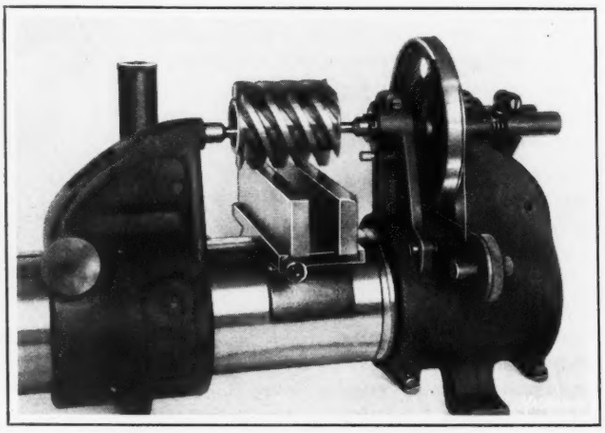


Fig. 2. Making Use of the Work-table in measuring the Length of a Part on the "Super-micrometer"

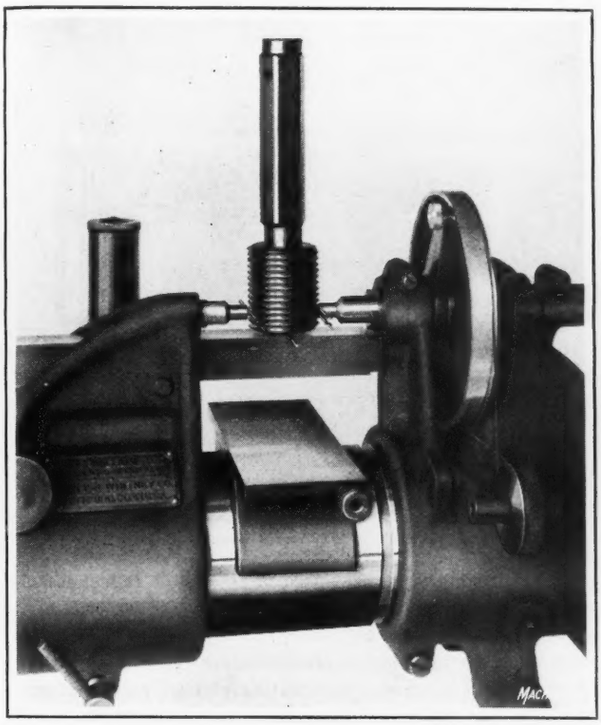


Fig. 3. Example in which the Part to be measured is held on the Square Bar employed in setting the Anvils

millionths inch. A square bar with a channel in one side provides for holding these blocks in place, as shown, while making the set-up.

The bar passes through the footstock and is mounted on a pin under the measuring spindle. The number of blocks used depends, of course, upon the measurement to be taken. In all cases the blocks take care of even inch measurements, while subdivisions of an inch are measured by means of the graduated spindle and disk. The spindle has an integral anvil and a working range of ½ inch with liberal over-travel each way. When the required number of inch-blocks are in place between the anvils and the spindle is set as required, the footstock is advanced by a rack and pinion mechanism to bring the anvil in contact with the blocks. The footstock is then clamped in position on the bed.

The measuring spindle is next removed from contact with the blocks by turning the graduated disk, and then again advanced into contact by turning handwheel *C*. This handwheel has two knurled steps, the smaller of which is used for quickly moving the spindle into contact and the larger for imparting the final slow movement to the point where slippage of the belt connecting the handwheel to the graduated disk, indicates that perfect contact is established. The belt insures the application of the same measuring pressure to the anvils each time. The graduated disk may be spun quite rapidly for setting up, but when taking a reading it must be brought up slowly until the belt slips. When contact has been secured, the zero arm *D* is set so that its zero line coincides with the zero mark on the graduated disk, the knurled knob *E* maintaining this setting. The inch-blocks are then removed and the work inserted in place.

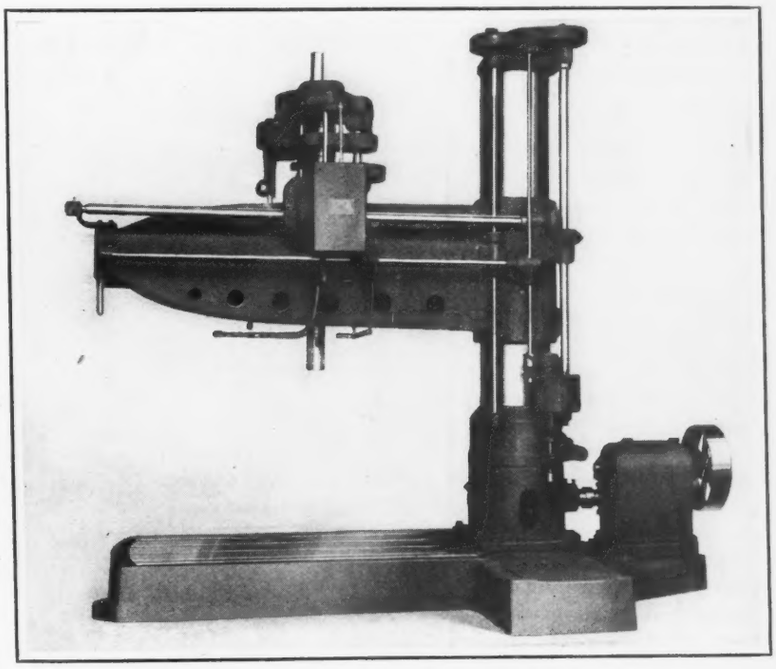
The work may be placed on the square bar used in setting the anvils; however, in this case the bar is inserted in the machine with the flat surface uppermost as illustrated in Fig. 3. The work-table shown in front of the machine in Fig. 1 is employed for supporting the work as illustrated in Fig. 2. Two of these tables are furnished. The height between the axes of the anvils and the top surface of this table is 3¼ inches.

The measuring spindle is mounted in split adjustable bearings located on each side of the graduated disk. Attached to the rear end of the spindle is an arm which straddles a fixed pin. This pin may be deflected slightly by means of adjusting screws, due to its being thinned down at the inner end. This arrangement serves to compensate for any exceedingly slight lead error in the screw, because as the arm moves along the pin when the latter is deflected, a slight turning movement is imparted to the spindle relative to the nut which offsets the amount of lead error that may exist in the screw. Springs on each side of the spindle at the rear end continually hold the side of the disk hub against the bearing, and thus eliminate errors due to endwise lost motion. Should the thread in the nut show appreciable wear, it may be taken up by tightening the steel collars around the hub of the index-wheel.

The spindle is graduated to 0.050 inch, which represents the amount that the spindle moves horizontally per turn of the disk. The disk has fifty main graduations with numbers indicating thousandths of an inch, and subdivisions reading directly to ten-thousandths of an inch. As the five hundred divisions on this 5-inch disk are not very closely spaced, it is easy to estimate subdivisions of the 0.0001-inch graduations. The footstock is held in alignment by a key engaging a keyway on the under side of the bed.

POWER CLAMPING DEVICE FOR DRESES RADIAL DRILLING MACHINES

Radial drilling machines built by the Dreses Machine Tool Co., 227-239 W. McMicken Ave., Cincinnati, Ohio, are now being equipped with a clamping device which receives power from the vertical driving shaft of the machines for clamping the column after the arm has been swung to bring the drill spindle into a new position. The device clamps the column without the operator having to change his position when drilling with the head near the outer end of the arm. A rear view of a machine equipped with this power clamping device is here illustrated. It will be



Dreses Radial Drilling Machine with Power Clamping Device for Column

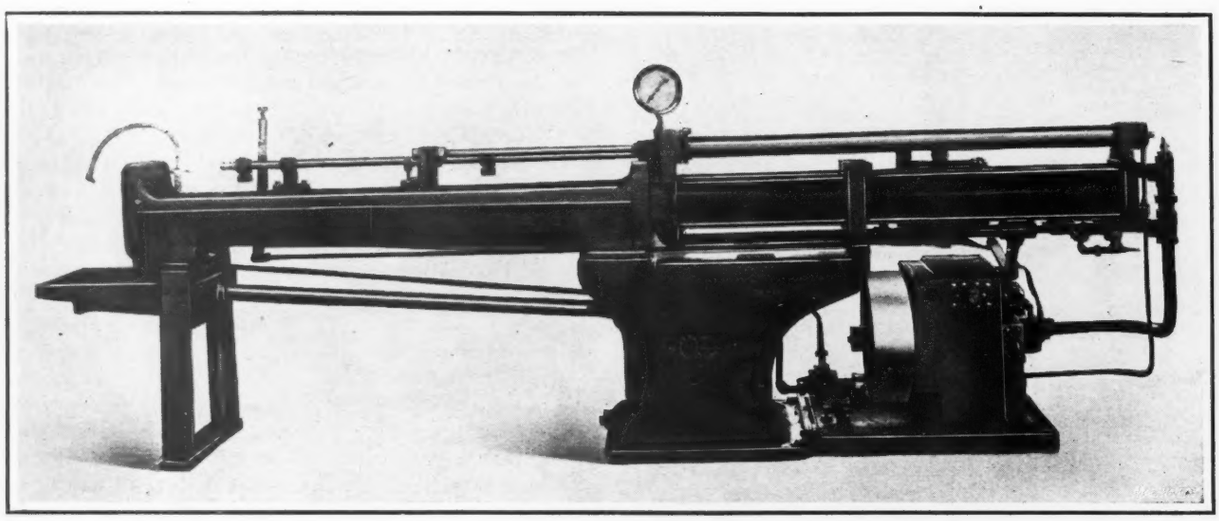


Fig. 1. Oilgear Broaching Machine with Cutting and Return Speeds ranging from 48 to 360 Inches per Minute

seen that the vertical driving shaft extends through a small oval box in back of the column. By means of a set of friction clutches in this box, the vertical screw which projects from the lower end of the box can be revolved either in a clockwise or in a counter-clockwise direction. On this screw is mounted a nut which is attached to a forked lever. The hub of this lever has a tapped hole, the threads of which engage those of the column binding screw.

The friction clutches are operated by a cam attached to a vertical splined shaft that extends to the top of the machine from the left-hand side of the oval box. This shaft is geared to a horizontal splined shaft that extends to the outer end of the column. The horizontal shaft is swiveled to throw the friction clutches into mesh, by means of levers and links which move along the arm with the drill head. The friction clutches are self-releasing. This power clamping device does not interfere with the use of the hand device.

OILGEAR HIGH-SPEED BROACHING MACHINE

Broaching at unusually high speeds, a practically unlimited choice of speeds within a given range, and an automatic control of the cutting and return speeds independently of each other, are the principal features of a hydraulic broaching machine recently developed by the Oilgear Co., 60-64 27th St., Milwaukee, Wis. Both the cutting and return speeds range from 48 to 360 inches per minute. A standard "Oilgear" variable-stroke pump, similar in design and operation to that used in variable-speed drives built by this company, delivers a steady flow of oil to a double-acting cylinder, the piston-rod of which is connected to a sliding head operating on the ways of a U-shaped trough. Fig. 2 shows a close-up view of the pumping apparatus.

The amount of oil delivered to the cylinder depends upon the length of pump stroke, which may be varied from zero to a maximum. As the speed of the piston travel depends upon the amount of oil pumped into the cylinder, this speed can be changed at will by merely changing the pump stroke. The fast operation of the machine is attributed mainly to this method of control. The cutting stroke is started without shock and the pull is steady. The slight variations in speed obtainable provide for selecting the correct speeds for different materials and different styles of broaches, the higher speeds being employed for light cutter-bar work, and the slower speeds for heavier jobs.

Automatic stops may be set for securing any desired length of cutting stroke, and this length will remain fixed. There is no danger of over-running, and consequently the broach will not be pulled beyond the reducing bushing and caught on the reverse stroke. Reversal at either end of the stroke is effected by simply pressing a push-button. In addition, the control may be set for automatic reversal. An emergency control lever enables the operator to stop the machine instantly at any point of the stroke.

Quick-acting relief valves prevent the pulling apart or the buckling of a broach under abnormal load conditions on either the cutting or return stroke. These valves, one of which is placed on the cutting end of the cylinder and the other on the return end, automatically relieve the pressure and stop the operation of the machine whenever the pressure reaches a predetermined point.

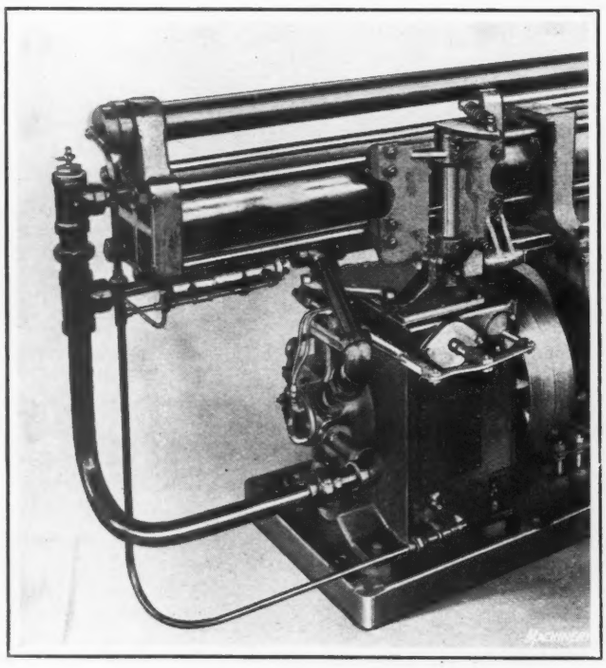


Fig. 2. Close-up View of the Oilgear Variable-stroke Pump employed in driving the Broaching Machine

The machine can be driven by belt from a lineshaft or by a motor. When a motor drive is employed, the motor is mounted above the main cylinder on an adjustable support. The following example is given as being typical of the performance of this machine: In broaching four solid keys in a differential bevel gear made of 0.22 per cent carbon steel and having a 1¼-inch bore, 2 inches long, the cutting speed was 288 inches per minute and the return speed 312 inches per minute. The average cutting time for this part was 6½ seconds.

The principal specifications

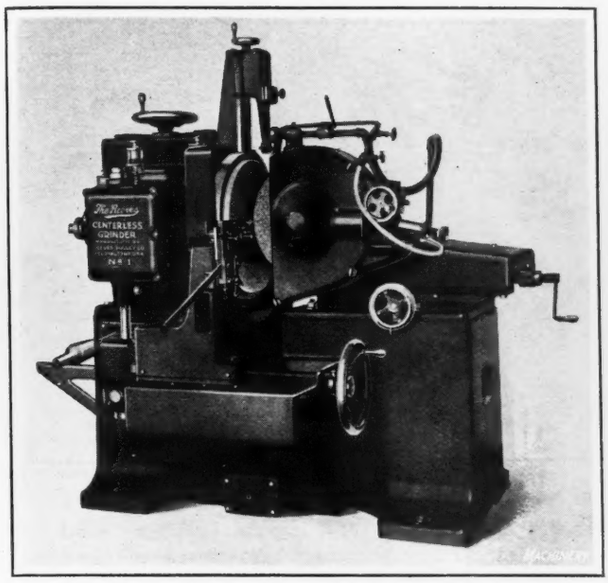


Fig. 1. Reeves Improved Centerless Grinding Machine, Suitable for grinding Shouldered, Tapered, or Straight Work

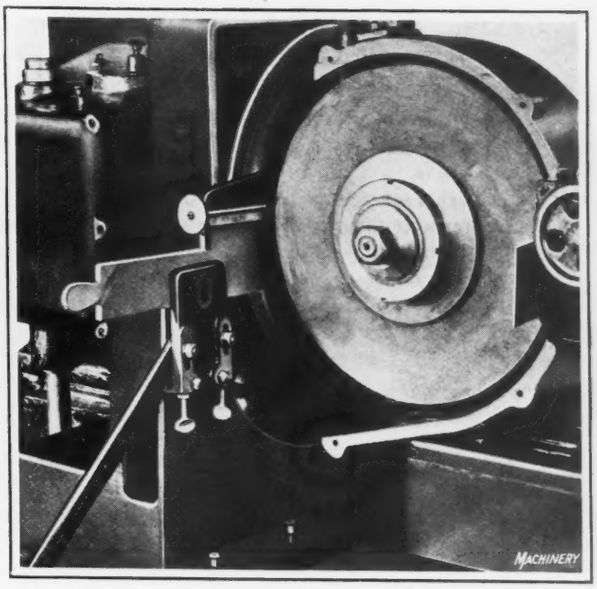


Fig. 2. Close-up View of the Reeves Centerless Grinding Machine, showing the Work-rest for Shouldered Parts

of this machine are as follows: Pulling capacity 16,000 pounds (equivalent to that required for a 2-inch square broach designed according to standard practice); maximum stroke, 56 inches; diameter of hole in faceplate, 5 inches; vertical adjustment of draw-head, 1⅝ inches above and 1⅝ inches below center; size of motor recommended for driving machine, 10 horsepower; approximate weight of machine, 2900 pounds; and floor space required, 16 feet by 26 inches.

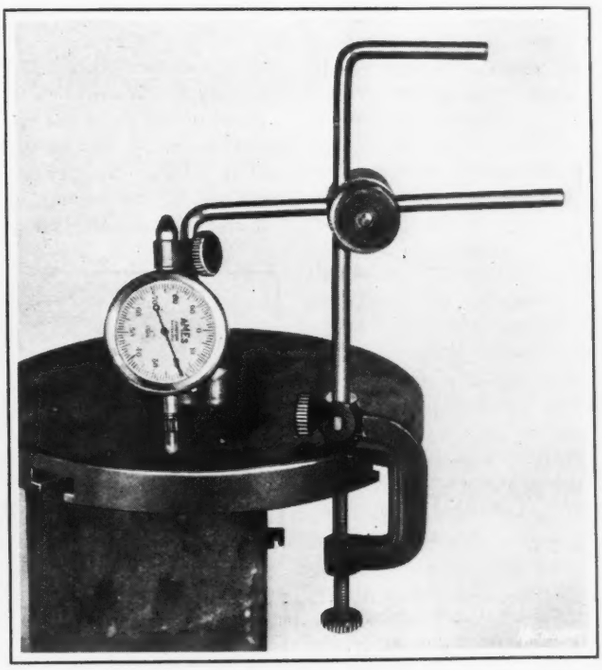
REEVES CENTERLESS GRINDER

A number of improvements have been made in the centerless grinding machine now being built by the Reeves Pulley Co., Columbus, Ind., which was described in June, 1919, MACHINERY, at the time that it was placed on the market by the Gardner Machine Co., Beloit, Wis. A general view of the redesigned machine is shown in Fig. 1. Among the most important of the improvements is a patented drop-in work-rest, which adapts the machine for grinding shouldered, taper, or straight work, including valve stems, shackle bolts, and similar parts. This work-rest consists of a steel bar having a hardened and ground edge which supports the work in a horizontal position between the two grinding wheels. On top of the bar there is an extended guide slotted to provide an opening just large enough to receive the work. On the sides of the bar are guide walls which hold the work in a straight line centrally between the two grinding wheels. A stop may be adjusted for grinding rolls of different lengths. This stop permits the rolls to extend in between the wheels just far enough to grind them without touching the shoulder.

A special feature of this rest is that it is mounted on rollers which permit it to be drawn forward, raised to allow the work to be entered lengthwise 5 inches or less above the grinding point, and lowered to the grinding position. Thus the piece is centered and ground its entire length and produced concentrically. This diamond dresser is adjustable for dressing the wheel to the necessary angle for grinding work to a taper. Provision is made for obtaining correct wheel balance, which is so essential in precision grinding. The balancing is accomplished without removing the wheel from the chuck by means of holes which are drilled around the chuck close to its periphery to receive balancing pins. These pins are placed in holes opposite the points where there are heavy spots in the grinding wheel and counterbalance them. Permanent balancing ways are regularly bolted to the base of the machine, and a tapered balancing arbor is furnished for the chuck.

AMES DIAL GAGE UNIVERSAL ATTACHMENT

A universal attachment intended for use in connection with "Junior" dial gage heads manufactured by the B. C. Ames Co., Waltham, Mass., is now being placed on the market by the same concern. From the illustration it will be seen that the attachment provides for holding the gage in every conceivable position in the vertical plans. The vertical rod may also be inserted in the horizontal holes of the clamp to hold the dial gage in various positions in the horizontal plane. The clamp provides means for attaching to a large variety of objects. This equipment is especially useful in checking the straightness of crankshafts, camshafts, and valve stems, the lift of valves and valve cams, the thickness of piston-rings, shims, bearing liners, etc., diameter of pistons, and accuracy of many other parts. The attachment may be furnished with the Ames cylinder gage outfit.

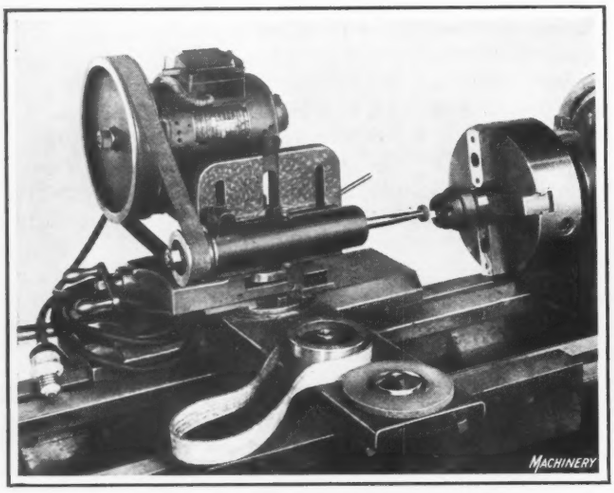


Ames "Junior" Universal Attachment for Use with Dial Gage Head

UNITED STATES LATHE GRINDING ATTACHMENT

An external and internal electric grinder which may be attached to lathes as shown in the accompanying illustration is a recent product of the United States Electrical Tool Co., 6th Ave. and Mount Hope St., Cincinnati, Ohio. This attachment may be applied to all lathes having a swing of 10 inches or more. The angle-plate of the grinder is bolted to the tool-rest of the lathe. The grinding spindle is mounted on the front of the angle-plate and may be clamped in various positions by means of two screws. It has a vertical adjustment of 4 inches and may be set at an angle for jobs requiring such a setting. The same spindle is used for both internal and external grinding.

The motor is mounted on the opposite side of the angle-plate from the spindle by means of a hinge pin. This pin allows the motor to be swung either toward the front or back to facilitate the changing of belts or to tighten them. The motor is of the universal type for operation on either direct or alternating current of 60 cycles or less. Both the motor and grinding spindle are fitted with ball bearings. Among the standard equipment are included three pulleys which give spindle speeds of 30,000, 16,500, 9500, and 5500



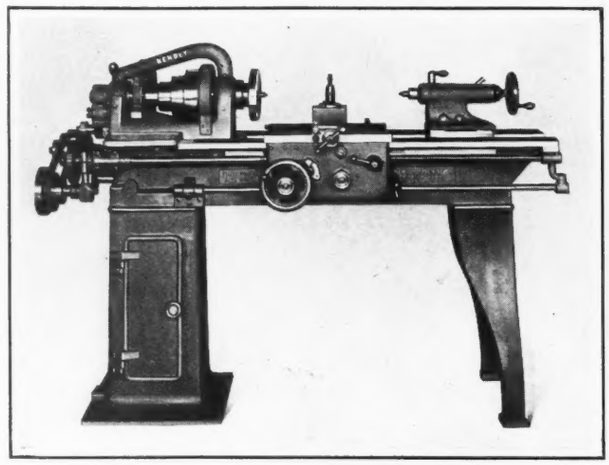
United States Electric Grinder attached to the Tool-rest of a Lathe

revolutions per minute; one wheel 6- by ¾- by ½-inch for external grinding, and one wheel 1- by ¼- by ¼-inch for internal grinding. Any size of wheel from an abrasive pencil to 6 inches in diameter can be used. The weight of the grinder is about 44 pounds.

HENDEY PLAIN-GEARED ENGINE LATHE

For light manufacturing purposes and for use in technical and vocational institutions, the Hendey Machine Co., Torrington, Conn., has brought out the plain-geared 12-inch lathe here illustrated. The headstock, tailstock, carriage, apron, and lead-screw are of the Hendey standard design. The machine is driven from a two-speed countershaft. This countershaft and the headstock construction provide sixteen speeds for the spindle. Change-gears and a belt running over three-step cone pulleys at the headstock end of the bed supply the necessary number of feed changes for cutting threads from two to thirty-six per inch. The lead-screw is 1 inch in diameter and has six threads per inch.

A guard which encloses the feed belt and change-gears was removed from the machine at the time the photograph was taken. The starting, stopping, and reversing of feeds are controlled from the apron. The cross-feed screw is graduated to thousandths of an inch. The bed is regularly



Hendey "Junior Model" 12-inch Engine Lathe

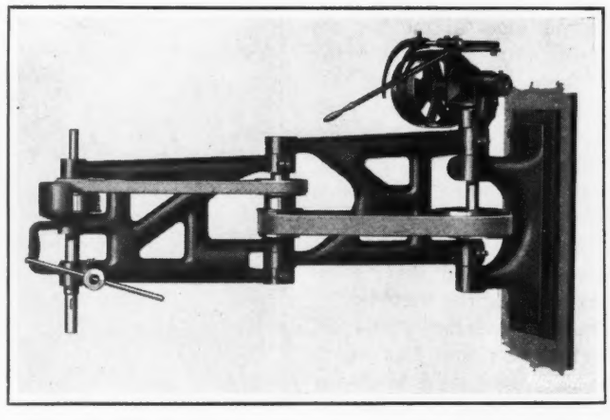
furnished in 4-, 5- and 6-foot lengths, but longer beds may be supplied. The cabinet leg has shelves and partitions for storage of the change-gears and other small parts. All attachments designed for the Hendey standard 12-inch lathe are applicable to this machine. Some of the principal dimensions are as follows: Diameter of hole through spindle, 15/16 inch; distance between centers, 27¼ inches; actual swing over bed, 12⅝ inches; and swing over carriage 7¼ inches.

HAMMOND WALL OR POST BRACKET DRILL

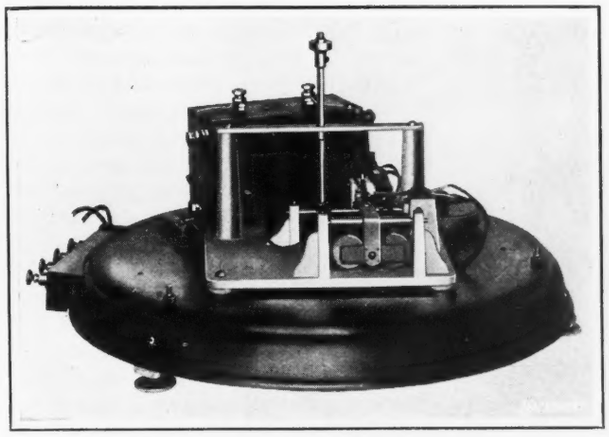
A bracket drill designed by the Hammond Mfg. Co., 6545 Carnegie Ave., Cleveland, Ohio, to be attached to a post or wall and used for light drilling operations on electrical parts or similar work is here illustrated. The equipment has a drilling radius of 42 inches. It is driven by means of a tight-and-loose pulley countershaft which transmits power through bevel gears to an upright shaft situated close to the base end of the bracket. This upright shaft, in turn, drives the spindle through pulleys and an intermediate shaft.

The countershaft yoke may be set in any position to suit an overhead drive, and is provided with a convenient belt shifter. By having the bracket arms swing on stationary sleeves, undue pressure on the driving shafts is eliminated. The spindle is equipped with a ball thrust bearing and a spring counterbalance. The quill of the spindle is made of steel and has bushed bearings and a rack cut from the solid.

Some of the principal specifications are as follows: Spindle traverse, 2½ inches; size of Morse taper hole in spindle, No. 2; drilling capacity in steel, ⅜ inch; speed of countershaft pulleys, 400 revolutions per minute; and spindle speeds, 500 and 1300 revolutions per minute.



Hammond Bracket Drill designed to be attached to a Post or Wall



Cleveland Electric Pyrometer for recording Temperatures up to 2500 Degrees F.

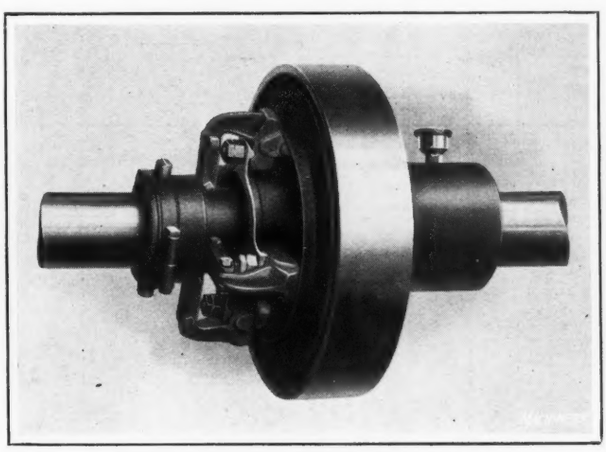
CLEVELAND ELECTRIC RECORDING PYROMETER

An electric pyrometer for recording temperatures from 0 to 2500 degrees F. in steel-treating furnaces, ceramic kilns, etc., is now being placed on the market by the Cleveland Instrument Co., 1988 E. 66th St., Cleveland, Ohio. This pyrometer is of a construction which permits any number to be operated by one master clock. The chart is 18 inches in diameter and scaled for either thermo-electric or resistance systems. The record is made by burning a small hole in the chart from the point of the galvanometer needle to the arc circle. The galvanometer is of the "Unipivot" suspension type in which the moving element or indicator is suspended by a phosphor-bronze member which is supported by one sapphire jewel and a steel pivot. The pivot supports only one-tenth of the weight of the moving element and thereby overcomes fragility. The relays are operated by 6-volt storage batteries.

WOOD'S IMPROVED FRICTION CLUTCH

An improved "Universal Giant" friction disk clutch manufactured by T. B. Wood's Sons Co., Chambersburg, Pa., has been especially designed to withstand severe shocks such as are produced in starting a machine, a battery of machines, or an entire plant. This clutch has a new type of fireproof friction lining which is called by the manufacturers "Non-burn." It is said that this lining has a considerably higher coefficient of friction than wood blocks and other materials previously used in the clutch and that the lining will not burn out.

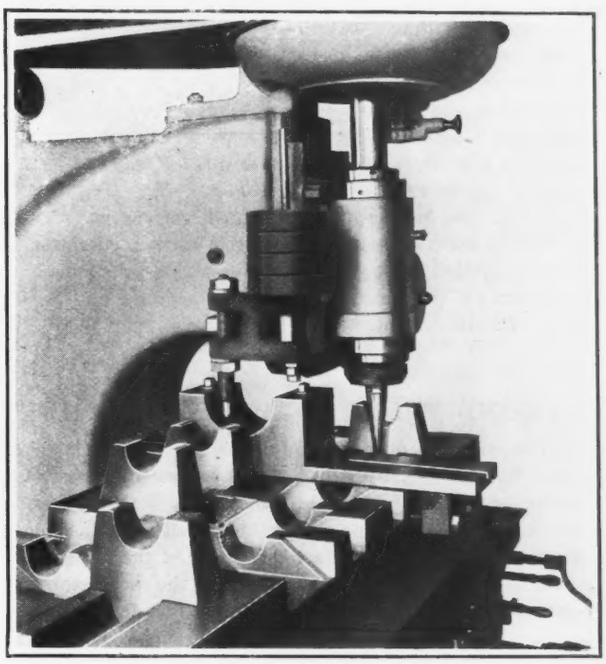
The clutch is of the floating disk type and may be furnished with one, two, or three disks. It is made in sizes having rated capacities of from 5½ to 480 horsepower at a speed of 100 revolutions per minute. This clutch is also still being made with wood blocks for installations in which the service does not require the improved type.



Wood's "Universal Giant" Friction Clutch which is provided with a Fireproof Lining

BECKER CHERRYING ATTACHMENT

Profiling in both the vertical and the horizontal plane on vertical milling machines built by the Becker Milling Machine Co., 677 Cambridge St., Worcester, Mass., has been made possible by means of a cherrying attachment lately developed by this concern. From the illustration it will be seen that a bracket provides for holding a vertical former-pin which can be adjusted up and down and locked in position by means of two nuts, the upper of which is graduated to thousandths of an inch. In an operation, this former-pin moves over a block having surfaces similar to those that are to be produced on the work. The cutter, of course, follows these movements. There are three holes in the bracket for the former-pin, which permits the positioning of the pin in line with the machine spindle or either 4 or 8 inches back of the spindle center. This allows more flexibility as to the location of the former-block.



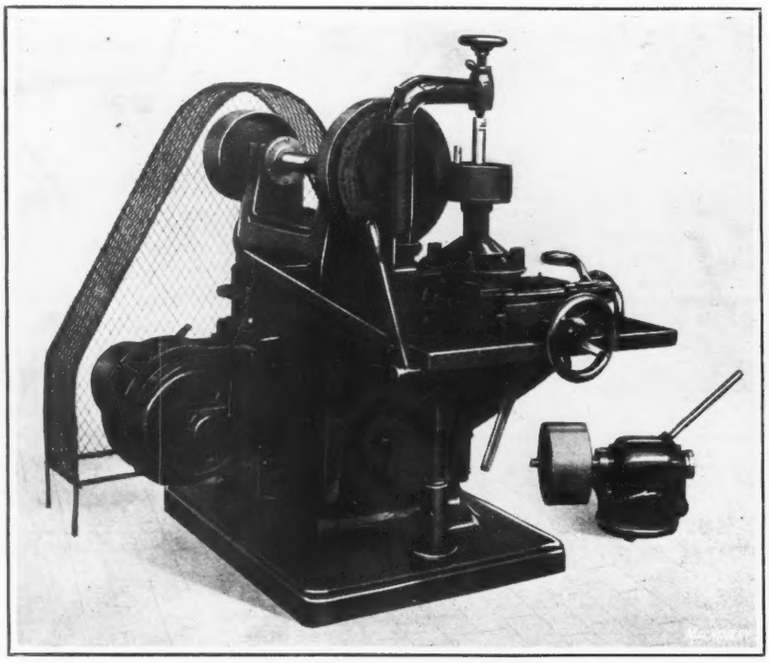
Attachment which adapts Becker Vertical Milling Machines for Profiling Operations

The former-block, as previously mentioned, is the same shape as the hole to be cherried, which in the majority of cases is semicircular. However, other shapes can be produced as, for example, an elliptical surface or an inclined surface having perhaps a fillet at one or both ends. The former blocks are designed to be attached to a plate and they may be moved lengthwise to any position on the plate and clamped by means of T-slots. The plate spans the work and is clamped to it on both sides, the clamping mean being adjustable so that the plate may be clamped on blocks of various widths.

In order to illustrate the use of this attachment, it will be assumed that it is desired to cut a semicircular depression having blind ends. The operator first selects a two-lipped cutter with the same radius on the end as the allowable fillet at the blind end of the hole and having a taper corresponding to the customary draft on dies. The cutter is fastened in the machine spindle in the usual way, and a former-pin is selected with one end having the same size fillet as the cutter end. The pin is placed in one of the

bracket holes and adjusted to the former-block, which has previously been clamped in position on the holding plate.

The machine is started, and with the former-block as a guide for the cutter, the operator starts at the top of one side of the former-block and by using the cross and vertical feeds, proceeds to the lowest point of the block. Then starting at the top of the other side of the block, he again proceeds to the lowest point, this time, of course, using the reverse cross feed. If it is necessary to take a second cut, the former-pin is adjusted vertically as many thousandths inch as required, and the cutting operation is repeated. Weights may be placed on the attachment to counterbalance the head. Patents are pending on the design of this attachment.



Diamond Grinding Machine for finishing Convex, Concave, and Flat Surfaces on Pulleys, Wheels, Rolls, etc.

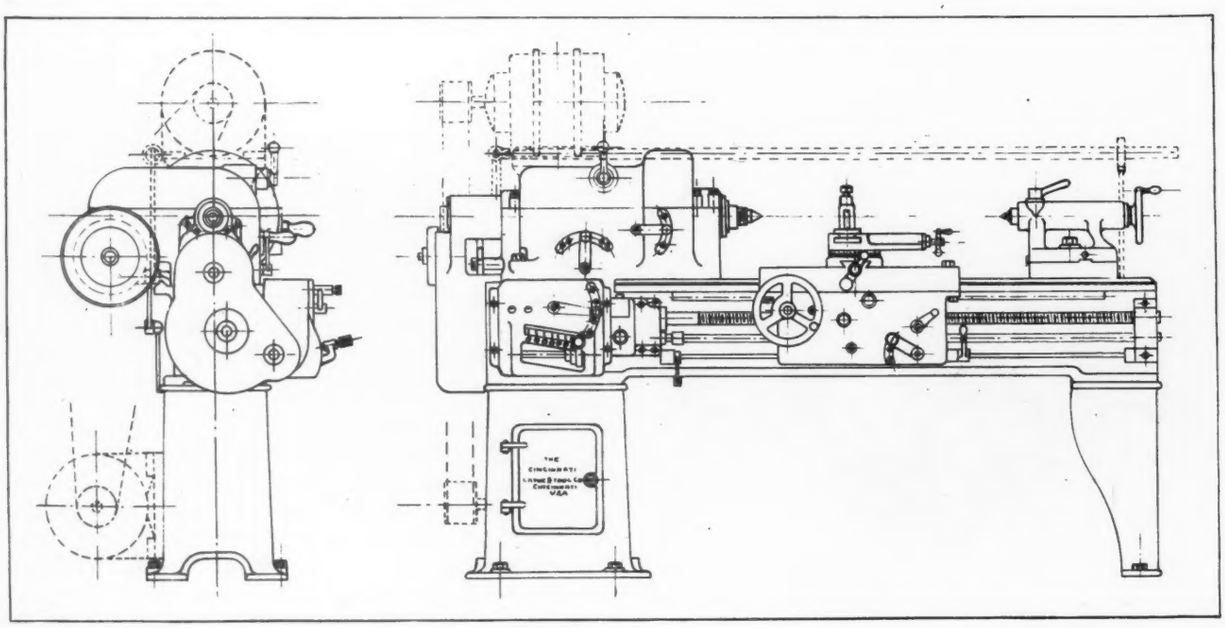
DIAMOND PULLEY-GRINDING MACHINE

Convex, concave, or flat surfaces can be quickly finished on such work as pulleys, wheels, and rollers by means of a grinding machine recently brought out by the Diamond Machine Co., 9 Codding St., Providence, R. I. The edges of the work can also be finished by the use of the attachment shown to the right of the machine in the accompanying illustration. The principle upon which the design of the machine is based is the same as that employed in the Diamond pulley grinding fixture described in February, 1921, MACHINERY. The grinding is accomplished by rotating the pulley against the ring-wheel. If the pulley is brought against the inner edge of the wheel, the crown will have the same radius as the inside of the wheel, and if the pulley is rotated against the wheel face it will be ground flat. By bringing the pulley to the outer edge of the wheel, negative grinding or a concave face will result.

The grinding speed may be varied by changing back-gears. The spindle is equipped with ball bearings and runs at the rate of 1500 revolutions per minute. It is driven from the motor through a silent chain, the motor being of 10 horsepower capacity and running at 1800 revolutions per minute. The ring-wheel is 14 inches outside diameter and has a 1-inch face. The machine is equipped with three guards that adequately enclose the work during an operation, these guards having been removed at the time the photograph was taken. A vertical pump is supplied for wet grinding. The edge facing attachment can be put on the machine or removed in from two to three minutes. Its correct alignment with the machine is assured by dowels and large holding-down screws. The attachment weighs about 50 pounds. The machine has a capacity for work from 2 to 18 inches in diameter and 1 to 6 inches in face width. It weighs about 2000 pounds.

CINCINNATI GEARED-HEAD LATHES

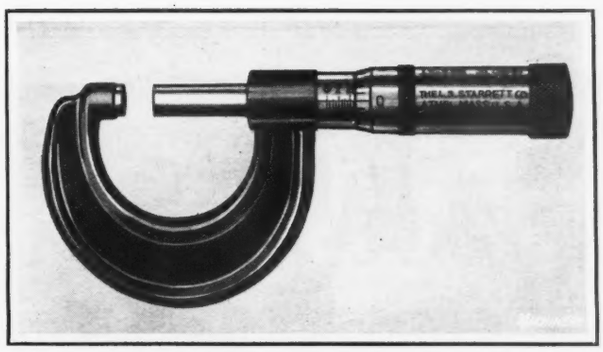
A line of geared-head lathes made in sizes of from 16- to 30-inch swing and capable of developing a horsepower double that of other lathes of the same nominal size manufactured by the Cincinnati Lathe & Tool Co., 3207-11 North St., Oakley, Cincinnati, Ohio, has been added to the line of machine



Cincinnati Geared-head Lathe which is built in Sizes of from 16 to 30 Inches Swing

tools built by this concern. When the lathes are motor-driven, the motor is mounted either on the headstock or on the rear of the cabinet leg and connected to the machine by a chain or belt running over an idler pulley. When driven from a lineshaft through a single pulley, either a rod running along the top of the lathe as shown, or a handle on the front of the headstock, is furnished for starting and stopping. An apron control can also be supplied when desired.

These lathes are equipped with a power disk clutch and a brake having a neutral position in which the spindle is entirely disengaged from all gearing. This feature eliminates the flywheel effect of heavy gears on a spindle, and is a time-saver in centering irregular work in a chuck or in machining small parts in which the chucking time is a large factor. Twelve spindle speeds are quickly obtainable by manipulating the three handles on the front of the headstock. The 16-inch lathe has a spindle-speed range of from 13.5 to 400 revolutions per minute in geometrical progression. It is said that the spindle speeds can be changed throughout the entire range in twelve seconds.



Starrett One-inch Micrometer Caliper

STARRETT ONE-INCH MICROMETER CALIPER

A No. 435 micrometer caliper which has just been added to the line of mechanics' tools manufactured by the L. S. Starrett Co., Athol, Mass., is shown in the accompanying illustration. This micrometer has a range of one inch. All its details have been proportioned to insure long life. The screw is 0.312 inch in diameter and the contact point 0.270 inch. The frame is a drop-forging and is coated with black enamel. Decimal equivalents are marked around the thimble.

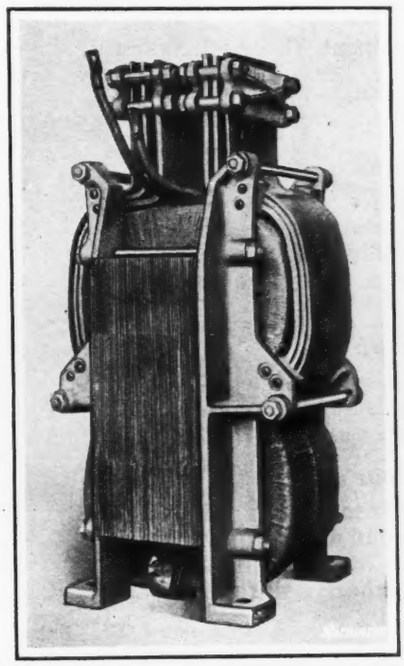
U. S. WELDING AND HEATING TRANSFORMER

A transformer intended for use on welding and heating equipment subjected to extra hard service, and where a high power is necessary, is now being placed on the market in various sizes by the U. S. Electric Welder Co., 327-328 Permanent Bldg., Cleveland, Ohio. The illustration shows the transformer as manufactured for mounting vertically on a butt-welder. However, it is also made in a horizontal type for mounting on other types of equipment.

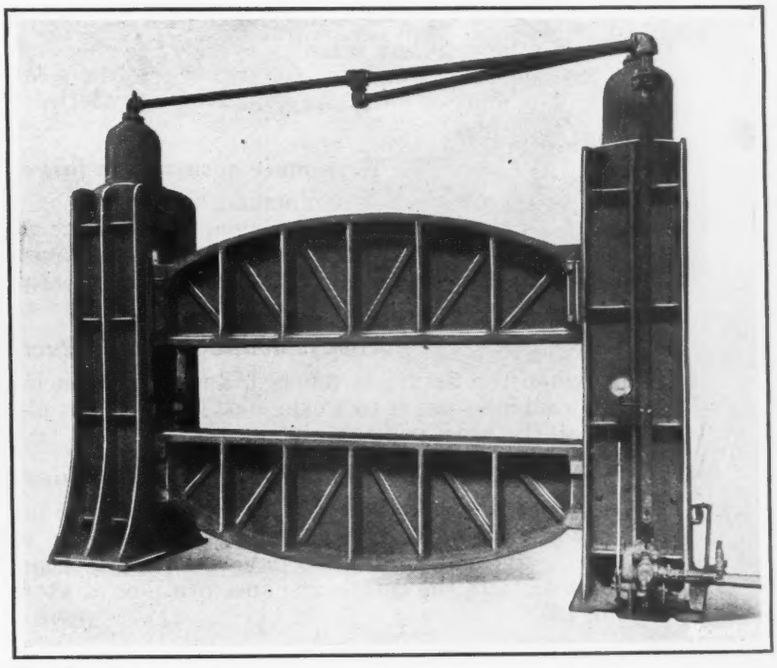
The support for the core and the primary and secondary coils is designed to prevent humming or shifting of these parts. The cooling surfaces in the primary and secondary coils are sufficiently large to insure that the temperature will be kept within safe limits during heavy overloads. It is stated that the temperature never rises above the room temperature more than 50 degrees C. The secondary coil is built up of heavy drawn copper bands which are securely insulated and supported. An internal automatic reactance prevents the current from reaching dangerous limits, eliminating breakdowns and increasing the welder's speed and power.

HYDRAULIC FLANGING PRESS

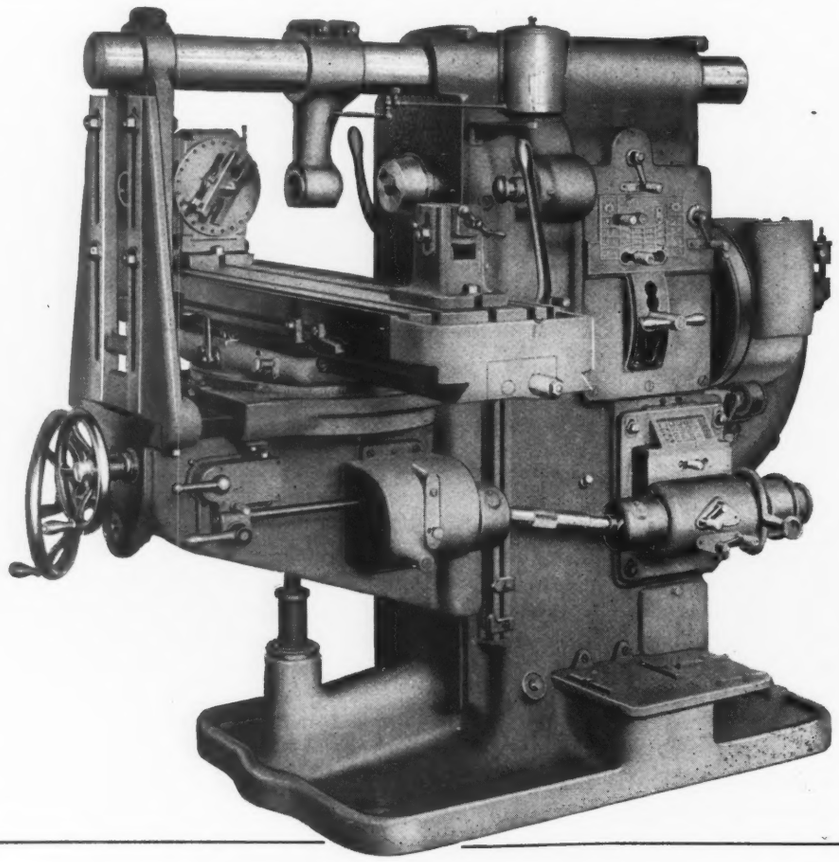
A very large hydraulic press capable of exerting a pressure of 435 tons has been built by the Hydraulic Press Mfg. Co., 84-88 Lincoln Ave., Mount Gilead, Ohio, for flanging plates used in constructing Murphy car ends. This press will flange steel plates cold up to 5/16 inch thick by 10 feet long. It is equipped with two 20-inch rams, and two 5½-inch auxiliary cylinders are used for returning the platen after an operation. All movements of the press are controlled by a three-way poppet-type high-pressure valve which is operated by the manipulation of a single hand-lever. The cylinders, platens, housings, etc., are steel castings. The press has a stroke of 24 inches and a maximum distance between platens of 36 inches. The total weight is approximately 42 tons.



U. S. Electric Welding and Heating Transformer



Large Hydraulic Press for flanging Steel Plate Cold



BROWN & SHARPE UNIVERSAL MILLING MACHINES

Adaptable Machines for Accurate Work

When a new milling machine is added to the shop equipment, there is usually some definite job in view for it. It may be a lot of big, heavy castings, followed by another lot of the same kind. Or between jobs there may be a large fixture to mill.

Extremely accurate on large fixtures

As for fixtures—your toolmakers may have had difficulties with an occasional big fixture—heavy, bulky—demanding accurate work to close limits. The manner in which the larger Brown & Sharpe Universal Milling Machines handle such tasks reveals their essential strength and precision. They are accurate, handy, thoroughly capable machines.

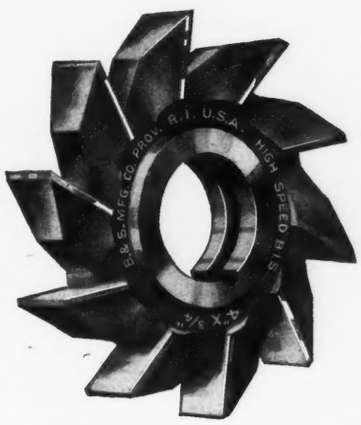
Always available for production work

If, when the fixture is finished, another production job is scheduled—there's the machine—put it to work. You'll find it has plenty of strength and stamina for all the work you can give it.

In our complete line is the machine for your work

Your problem may be quite different from the one outlined here. Whatever your problems are, send for our General Catalog listing our entire line, including six styles of milling machines covering a broad range of sizes. Become acquainted with the details and specifications of these machines. Ask for Catalog No. 137.

BROWN & SHARPE COARSE-TOOTH MILLING CUTTERS



The advantages of coarse-tooth cutters

Among the many types and styles of modern cutters, Brown & Sharpe Coarse-Tooth Milling Cutters possess advantages which deserve consideration.

Take heavy cuts at small power cost

Two distinct economies are secured by this coarse-tooth design. A larger amount of metal is removed per unit of time and the power consumed is less per unit of metal removed. Taking heavier cuts at reduced power cost means money saved on every job.

No vibration or chatter

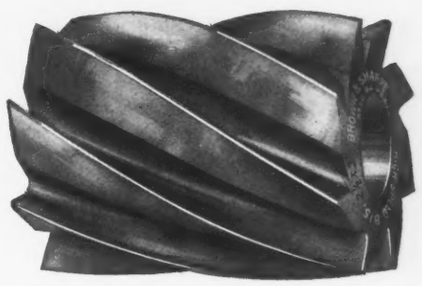
This coarse-tooth construction enables every tooth to remove a proportionately large amount of material. These substantial cuts eliminate vibration and chatter, producing a surface noticeably free from chatter marks. Finishing a surface in a single deep cut is customary practice with coarse-tooth cutters.

The wide spaces between teeth allow the cutting edges to be well backed up. This added support gives each tooth a strength greater in proportion than the increase in work of which each tooth is capable. This means that although each tooth removes a larger chip there is still a surplus of strength to meet an emergency. These cutters take deep, rapid cuts without danger of failing.

An effective angle of rake

The angle of rake is sufficiently acute to give a sharp cutting edge without diminishing tooth strength. This rake gives the teeth a freer cutting action, which rids the cutter of any tendency to push or drag. The resulting decrease in friction leaves the teeth cooler—and a cool cutter does more work with fewer sharpenings. The increased spiral angle on wide cutters gives them a shearing action with portions of several teeth cutting at the same time. Freedom from chatter and "banging" of the teeth is the result. The cutting action becomes continuous.

An increased spiral angle



Proved reliability

With these features in mind, consider the milling jobs where you can use Coarse-Tooth Cutters to advantage. They will increase production and lower operating costs. Insist on the name BROWN & SHARPE. It is a guarantee of cutter quality.

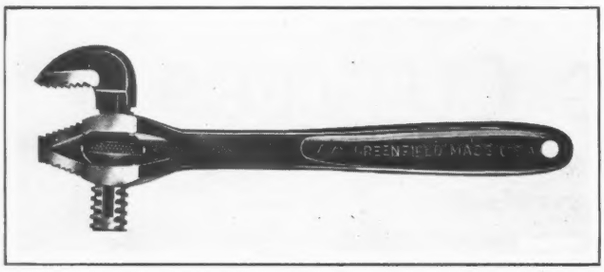
Send for Catalog No. 28 describing our cutters

BROWN & SHARPE MFG. CO.

Providence, R. I., U. S. A.

GREENFIELD PIPE WRENCH

A pipe wrench of simple construction, having the end opening common to machinists' wrenches, has recently been placed on the market by the Greenfield Tap & Die Corporation, Greenfield, Mass., under the trade name of "Little Giant." This wrench consists of three parts, a combined handle and jaw, a movable jaw, and a steel adjusting nut.



Greenfield "Little Giant" Pipe Wrench the Design of which permits its Use in Close Quarters

The combined handle and jaw and the movable jaw are drop-forgings, and all three parts are heat-treated.

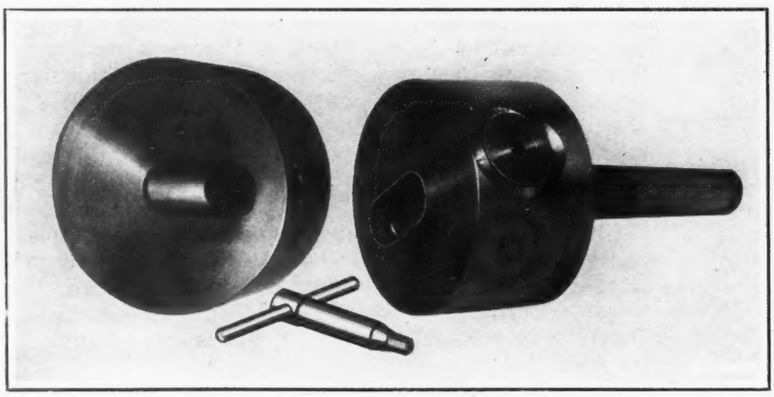
Both the main and the movable jaws have teeth which grip the pipe. The main jaw has teeth on both sides, and the movable jaw can be reversed so that it is possible to grip work between it and either of the sets of teeth on the main jaw. This design considerably lengthens the life of the wrench. On the larger sizes, the main jaw is provided with two additional sets of teeth on the part where it joins the handle.

The wrench is manufactured in 8-, 10-, 14-, 18- and 24-inch sizes. It is claimed that the 14-inch wrench has repeatedly stood stresses in excess of 4700 inch-pounds without slipping or bending. The Army and Navy specifications for a wrench of this size only require that it withstand a stress of 2800 inch-pounds.

EDLUND ADJUSTABLE BORING HEAD

An adjustable boring head designed for both tool-room and manufacturing purposes has been placed on the market by the Edlund Machinery Co., Inc., Box 57, Cortland, N. Y. The body of the head carries a round plunger into which the boring-bar is secured. The position of the boring-bar relative to the axis of the head is adjusted by means of a feed-screw. A stiff spring provides for taking up any wear of the feed-screw and thus eliminates backlash. The feed-screw is fitted with a dial which is movable relative to the screw, so that it is always possible to start turning the screw with the dial positioned with its zero graduation opposite the scribed line of the head. A long taper key locks the plunger in position. The head is simple in construction and all moving parts are hardened and ground.

This tool is being manufactured in four sizes; the No. 0 size takes a ¼-inch boring-bar, may be offset ¼ inch from the center, and will bore holes from ¼ to ¾ inch diameter; the No. 1 size takes a ½-inch boring-bar, may be offset ½ inch from the center, and bores holes from ½ to 1½ inches in diameter; the No. 2 size takes a ¾-inch boring-bar, may be offset ⅝ inch from the center, and bores holes from ¾ to 2 inches in diameter; and the largest size (the No. 3) takes a 1¼-inch boring-bar, may be offset 1¼ inches from the center, and will bore holes from 1¼ to 3¾ inches in diameter.



Edlund Adjustable Boring Head made in a Number of Sizes for Tool-room and Manufacturing Use

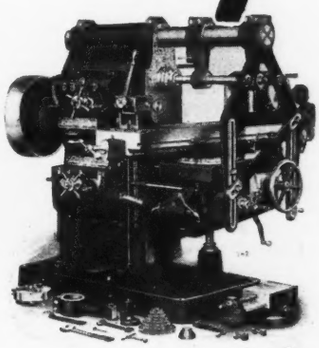
NEW MACHINERY AND TOOLS NOTES

Profiling and Milling Machine: Robbins Machine Co., 42 Lagrange St., Worcester, Mass. A vertical-spindle profiling and milling machine which differs considerably from customary design. The cross-feed screw is operated through helical gears from a handwheel in the same plane as the traverse handle. This design enables the operator to feed the table both crosswise and lengthwise simultaneously. The lengthwise traverse of the table is 12 inches, and the cross movement 7 inches. The knee may be moved 6 inches vertically, and the spindle 2¾ inches.

Welding Machine: General Welding & Equipment Co., 74 Brookline Ave., Boston, Mass. An automatic welding machine on which the torch is mounted at one end of a connecting-rod that receives motion through a crankpin at the other end. The welding rod passes through the center of the torch and is fed by gravity. The torch will travel in an egg-shaped path of which the proportions may be changed, and, in addition, the entire machine may receive motion at right angles to the mean of the motion imparted to the connecting-rod. An additional torch which precedes the welding torch and preheats the metal, is supplied for heavy welds.

Electric Nut-, Screw-, and Stud-setter: Elecdrive Mfg. Co., Inc., Drawer 34, Syracuse, N. Y. An electric tool for setting nuts, cap-screws, wood-screws, and studs. The spindle of the tool can be driven in both clockwise and counter-clockwise directions to permit it to be used for screwing left-hand nuts and unscrewing right-hand ones. It is manufactured in both portable and stationary types. The portable tool resembles an electric drill and operates from an electric light socket supplying either direct or alternating current. The stationary type is intended for connection to a power line. A special feature provides for the slow setting of nuts or screws, obviating the stripping of threads, straining of bolts or injury to the tool. Nuts may be picked up from the bench with the tool running at full speed.

Polishing and Buffing Lathes: Mitchell Engineering Co., Springfield, Ohio. A line of polishing and buffing lathes of which the No. 5 has two independent spindles. With this construction the stopping of one spindle for changing wheels or for other causes does not interfere with the operation of the second spindle. Either or both spindles may be removed with their bearings by releasing clamps and may be readily replaced without disturbing the alignment. The No. 5 machine may be driven by a motor mounted in the base connected to the spindles by belt. The No. 6 machine has a single spindle arranged for carrying a wheel on each end. The distance between the wheels on the No. 5 machine is 57 inches, and the diameter of the flanges is 4 inches. The approximate weight of the machine is 950 pounds.



Good design in a vital spot—

—The main spindle bearing of the Cincinnati Milling Machine

The box machined, inside and out, with three circumferential dovetail grooves, on the inside.

Showing the axial dovetail grooves.

The bearing metal cast in place

The bearing metal thoroughly compressed and forced into the grooves, rendering it dense and homogeneous. It becomes an integral part of the cast iron box and will not work loose.

The finished bearing. It is bored, accurately reamed, oil grooved and then ground on the outside concentric with the bearing.

The main spindle bearing is the very heart of the miller. We recognized this when we developed our special design many years ago.

Because of its proved excellence we are using it today.

It consists of a cast iron box with a special composition lining, composed of 90% tin and no lead. But its value is not entirely in this unusual material. The way we make it has much to do with its success.

This bearing has proved so very satisfactory that we believe it to be unsurpassed.

We submit it as another example of Cincinnati Miller excellence.

Ask for our New Book, "Tool Room Methods"

Cincinnati Milling Machine Co.

Cincinnati, Ohio

TENDENCIES IN GRINDING MACHINE DESIGN

Machine tool design constantly tends toward the elimination of overhead driving belts. In grinding machines, especially, recourse has been made to several methods of power transmission for driving the headstock spindle. Among these methods are included a drum supported by pedestals, and arrangements of gears and shafts. In some designs a constant-speed motor is mounted on the headstock, and the spindle is driven either through cones and clutches or trains of gears.

What appears to be the ideal plan for driving the headstock spindle is to embody a variable-speed motor in the headstock casting. A headstock of such a design is now in the experimental stage at the works of the Norton Co., Worcester, Mass. The photographs here reproduced were taken from drawings of a 14-inch headstock in which is placed a 2-horsepower variable-speed direct-current motor.

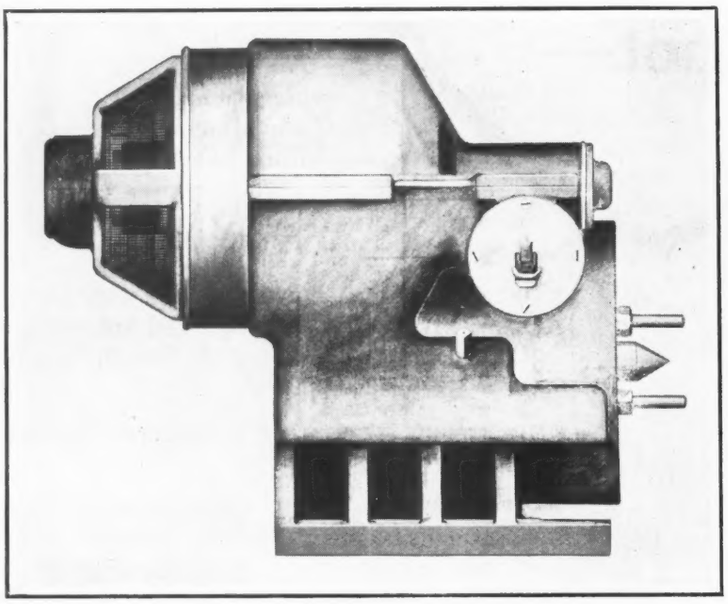


Fig. 1. Headstock Design for Grinding Machines in which a Variable-speed Motor is embodied in the Headstock Casting

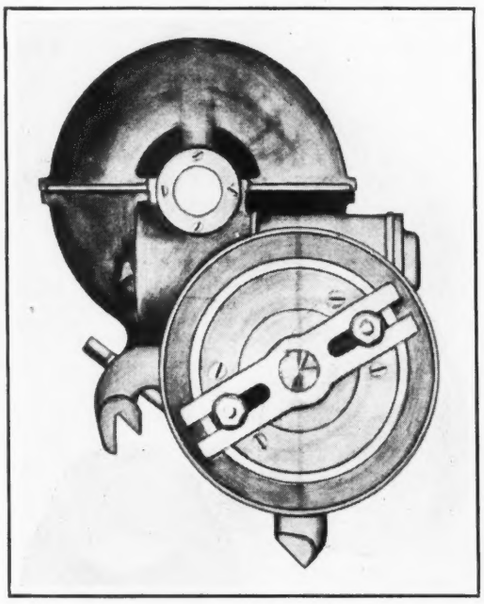


Fig. 2. End View of the Grinding Machine Headstock illustrated in Fig. 1

The motor speed variation is 3 to 1. In the event that this drive proves particularly satisfactory, it will probably be used by builders of grinding machines in general.

* * *

NEW APPLICATION OF OXY-ACETYLENE CUTTING

A machine which has created considerable interest during its development in England is the Godfrey oxy-acetylene cutting machine. In its present state it is a very efficient machine, working with an oxy-acetylene cutting blow-pipe in place of an edge tool. All cutting movements and the supply of oxygen in the correct proportions to suit the rate of feed are automatically controlled. In the latest model the oxygen is preheated prior to its passage through the blow-pipe, and this not only provides much cleaner cuts, but also speeds up the rate at which the blow-pipe can be fed. It is now possible to cut through ¾-inch mild steel plate at 17 inches per minute. One of the uses to which this machine is being put is the cutting of locomotive motion links. Links have been cut for the Midland Railway, 2½ inches thick, with a total length of cut of 80 inches. The time taken was 14 minutes 23 seconds, giving an average cutting speed of 5.55 inches per minute. The oxygen consumed was 38 cubic feet. The finish of the cut surface is said to be remarkable for its regularity; in fact, only on the running surface is it necessary to apply any other finishing operation.

PERSONALS

A. M. LINDSLEY, chief engineer of the Alvord Reamer & Tool Co., Millersburg, Pa., has been placed in charge of the advertising department of that company. He will continue his duties as chief engineer, coordinating the work of the two departments. Previous to his association with the Alvord Reamer & Tool Co., Mr. Lindsley was connected with the Cincinnati Milling Machine Co., Cincinnati.

WILLIAM H. LOLLEY, special representative for the Standard Parts Co., Cleveland, Ohio, sailed for Europe, August 1. Mr. Lolley will negotiate with German and French interests for the manufacture and sale of Bock taper roller bearings on the Continent. He will also visit the British Bock Bearings, Ltd., which was organized last year for the manufacture and sale of Bock bearings in the British Isles and possessions.

A. T. DOUD, Philadelphia, Pa., has acquired the Precision & Thread Grinder Mfg. Co., located at 1 S. 21st St., Philadelphia. Mr. Doud is a graduate in mechanical engineering of Purdue University. He was formerly mechanical engineer for the Hale & Kilburn Co., of Philadelphia; general superintendent of the Speakman Co., Wilmington, Del., and works manager of the Diehl Mfg. Co., Elizabeth, N. J. During the war he was general manager of the Hero Mfg. Co., Philadelphia. Since the war he has been manager of manufacturing for the American Tube & Stamping Co., Bridgeport, Conn.

HENRY HARNISCHFEGER, president of the Pawling & Harnischfeger Co., Milwaukee, Wis., recently returned from a six months' tour around the world, during which he visited Japan, China, the Philippine Islands, India, and several of the European countries. The object of the trip was to investigate the business conditions and trade possibilities in the Far East, particularly in Japan, China, and India, where the Pawling & Harnischfeger Co. has branches. Mr. Harnischfeger was much impressed by the possibilities in the Far East, and believes that there is a good market there for labor-saving machinery of all kinds.

* * *

The production of automobiles reached the highest peak in the history of the industry in June, when 261,963 passenger cars were completed in addition to 25,912 trucks. It is not expected that the production rate for the month of June will continue for the remainder of the year. Should it do so, it would mean a production of over 2,500,000 cars for 1922, which is, without doubt, a much higher figure than may be expected. If the production reaches 2,000,000 passenger cars for the year, and 250,000 trucks, the automobile industry will have to consider that it has had a very active year.

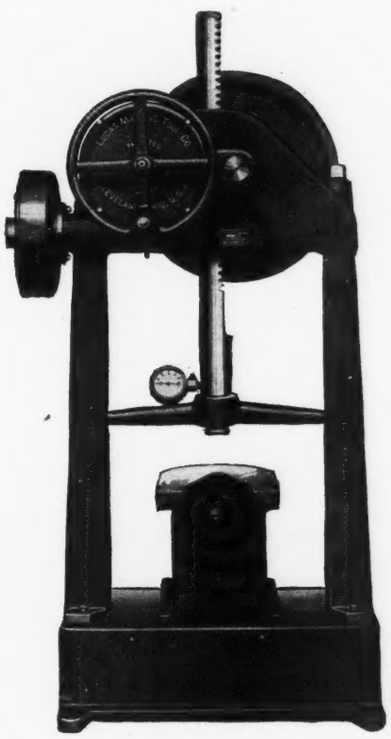
Take Us Into Your Confidence!

We frequently run across some peculiar job that can be done on the

LUCAS
Power Forcing Press

better than on any other machine.

If you have any jobs requiring pressure
Let us look them over, maybe we can help.



Illustrated Circular
Tells the Whole Story

WE ALSO MAKE THE
"PRECISION"

BORING, DRILLING AND MILLING MACHINE

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

TRADE NOTES

ASSOCIATED ENGINEERS, INC., Milwaukee, Wis., announces that the organization has removed to larger quarters at 373 Broadway, Milwaukee.

HERBERTS MACHINERY & SUPPLY CO., Los Angeles, Cal., has recently taken over the exclusive selling rights of the machines built by the Gisholt Machine Co., Madison, Wis., for the states of Arizona, California, and Nevada.

SCHEID ENGINEERING CORPORATION, 90 West St., New York City, has been appointed metropolitan and export representative for the Franklin Moore Co., Winsted, Conn., manufacturer of material handling machinery for industrial plants.

NATIONAL TOOL CO., Cleveland, Ohio, has taken over the "Save-All" chuck business formerly conducted by J. C. Dufresne, Waltham, Mass. Mr. Dufresne will remain with the National Tool Co. as manager of the "Save-All" chuck business.

CHICAGO FLEXIBLE SHAFT CO., 1154 S. Central Ave., Chicago, Ill., announces that the company's New York office for Stewart industrial furnaces has been removed from 350 Broadway to 16 Reade St. The office, as before, is in charge of J. W. Lazear.

VAN DRESSER BROS., 1157 Concord Ave., Detroit, Mich., manufacturers of cylinder reboring equipment, announce that the sales and distribution of Van Dresser cylinder reboring tools will in the future be handled directly by Van Dresser Bros. at their Detroit address.

WISCONSIN ELECTRIC CO., 2551 16th St., Racine, Wis., manufacturer of "Dumore" electrical tools and appliances, has appointed E. S. McGonegal resident sales representative in the metropolitan New York and northern New Jersey districts, with offices at 27 Warren St., New York City.

MILWAUKEE MACHINERY CO., Milwaukee, Wis., has moved from 124 Second St. to new quarters at 93 W. Water St. The new location will be used for offices as well as for a display room, and machine tools, electrical equipment and woodworking machinery will constantly be on exhibition.

DIAMANT TOOL & MFG. CO., INC., 95 Runyon St., Newark, N. J., has appointed Samuel W. Hay's Sons, 1410 Keenan Bldg., Pittsburg, Pa., exclusive representatives of the company for the sale of Diamant standard punch and die sets in the territory covered by the counties of Allegheny, Westmoreland, Washington, Armstrong, Indiana, Cambria, Somerset, Fayette, and Beaver in the state of Pennsylvania.

MITCHELL ENGINEERING CO., Springfield, Ohio, announces that it has recently been incorporated for the manufacture of a line of polishing and buffing lathes. The products are the design of R. C. Mitchell, who for a number of years was designer and factory manager for the Webster & Perks Tool Co. of the same city. P. A. Schaefer, vice-president and general manager of the new company, was formerly in charge of sales and advertising for the Webster & Perks Tool Co.

AIR REDUCTION SALES CO., 342 Madison Ave., New York City, announces that the company has under way a program of plant expansion of considerable magnitude. Sites have been purchased for an Airco acetylene plant at Birmingham, Ala.; an oxygen plant at Milwaukee, Wis.; and an acetylene plant and a calorene plant at Pittsburg, Pa. Construction of the plant at Birmingham has already begun, and plans are well under way for the erection of the plants at Milwaukee and Pittsburg. In addition to these new plant installations, the company's facilities for producing oxygen from the air will be enlarged in Buffalo and Minneapolis. The estimated cost of the proposed additions is over half a million dollars.

VALABHDAS RUNCHORDAS & CO., 70 Apollo St., Bombay, India, announce that they are in the market for lathes, milling machines, shapers, drilling machines and other machine tools for small machine shops. They are also in the market for electric motors from 1 to 10 horsepower for machine tool and woodworking machinery drives. In addition, they are interested in machinery for manufacturing phonograph horns at a production rate of about 500 a month, together with machinery for spraying or painting such horns as well as machinery for sheet-metal toys, with machinery for painting or spraying. They are also in the market for machinery for making phonograph needles and sewing needles, and for making sheet-metal boxes for phonograph needles.

PRECISION & THREAD GRINDER MFG. CO., 1 S. 21st St., Philadelphia, Pa., has been acquired by A. T. Doud of Philadelphia, who will act as president and treasurer of the company. F. V. Doud is secretary, and C. A. White, secretary of the Leeds & Northrup Co., will serve with the officers mentioned on the board of directors. F. Rodger Imhoff, former sales manager of the company, will be associated with the new organization as consulting engineer. The company will continue to manufacture its multi-graduated precision grinder; its thread lead variator for obtaining precision lead from the ordinary lathe lead-screw; its gage-block for testing lead-screws and for setting and testing the lead variator; and its permanent alignment wheel truing head for use on precision grinders, which is also applicable as a truing device on any grinding machine where it is necessary to shape the wheel face.

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OBITUARIES

FRANK BURR SMITH

FRANK BURR SMITH, works manager of the Bullard Machine Tool Co., Bridgeport, Conn., died August 16, at Grace Hospital, New Haven, Conn., from an acute attack of appendicitis. Mr. Smith was fifty years old. He was born at Mohican Springs Farm, Fairfield, Conn., in 1872, and obtained his early education in the public and high schools of Bridgeport. In 1890, he entered the employ of the Bullard Machine Tool Co. at their old Broad Street plant as a machinist apprentice. Upon the completion of his apprenticeship he was connected with the engineering department, but he soon had to go to Colorado on account of bronchial trouble. Upon his return to the East he was connected with a number of firms including the Atlantic Iron Works of Boston and the Laird Gold Production Co., with whom he served as mechanical engineer. In 1903 he entered the employ of the De LaVergne Machine Co. as erection and installation engineer.

In 1911 he returned to the Bullard Machine Tool Co. and represented this company in a sales capacity in Chicago, Cleveland, and Philadelphia. The last year of his sales work he spent in England, but returned in 1915 to Bridgeport and became manager of the employment and industrial relations department at the Broad Street plant of the Bullard Machine Tool Co. His efforts in this capacity were largely responsible for the harmony that prevailed in the Bullard organization during the entire period of intense activity following 1915. When all manufacturing of the Bullard company was transferred in 1920 to the new plant at Black Rock, Mr. Smith was made works manager and continued in this capacity until his death. He is survived by his wife and a brother, Hubert C. Smith, of Milford, Conn.

COLEMAN SELLERS, JR.

COLEMAN SELLERS, JR., president of William Sellers & Co., Inc., Philadelphia, Pa., died August 15, after an illness of several months, at the age of seventy. Mr. Sellers graduated from the University of Pennsylvania, and in 1873 began work with the Sellers firm. After serving an apprenticeship in the shops of this company for several years, he entered the drafting-room, of which he soon became the head. He was appointed assistant manager in 1887, becoming at the same time a director. In 1902 he was made engineer of the company, and in 1905 president, an office which he held continuously until his death.

Mr. Sellers came from a family that in four preceding generations had given many evidences of unusual mechanical and engineering ability. His father, Coleman Sellers, was well known as one of the most brilliant mechanical engineers of his time. Mr. Sellers, like his father, had many interests besides those in mechanical and engineering lines—scientific, literary and educational, and was active in the civic life of Philadelphia. He played an important part in the affairs of the Franklin Institute, and was vice-president of the institute at the time of his death. In 1907 he was appointed a member of the Board of Commissioners of Navigation of Pennsylvania. He took special interest in the work of the American Philosophical Society, the American Society of Mechanical Engineers, the American Society of Naval Architects and Marine Engineers, and the Engineers Club of Philadelphia, of which he was one of the founders. He was president of the Philadelphia Chamber of Commerce from 1909 to 1913. He also served as chairman of the local Draft Board during the early stages of the war, and devoted so much time and energy to this work that it is believed that it seriously impaired his health and contributed not a little to his subsequent illness.

Mr. Sellers was known as a kind and considerate man, and as one had an especial sympathy for the young men of his profession—those just stepping upon the lower rounds of the ladder which he had so successfully climbed.

How WETMORE Reamers

help to put quality and precision into the famous

WISCONSIN MOTOR

Wetmore Shell Reamers Used for Line Reaming

Four Wetmore Shell Reamers used for line reaming, (single bar) on the main crankshaft bearings of a fire truck motor in the Wisconsin Motor Mfg. Co. shops, Milwaukee.

AFTER severe tests, in competition with other reamers, production officials of the Wisconsin Motor Mfg. Co., unhesitatingly endorse Wetmore Expanding Reamers. Not only do they excel in *durability*, but they insure greater *accuracy* and speed—guaranteed, straight round holes—than have been obtained by reamers costing almost twice as much.

You, too, will find that Wetmore Reamers give greater precision, longer life and lower reaming costs. Here are some of the features that are making Wetmore Reamers standard equipment in hundreds of America's largest and best shops:

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone expansion nut keeps blades always parallel with axis.

Solid, heat-treated alloy steel body guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering, and scoring of the reamer while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.

***Let us send you a complimentary copy of our 1922 Handbook—a valuable reference book on precision tools. Write for it on your business letterhead. Sent* free, postpaid.**

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60-64 27th Street Milwaukee, Wis.

Manufacturers of Expanding Reamers and Cylinder Reaming Sets, Arbors, Blades, and Thread Gages.

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Mr. W. R. Wyatt, 50 Church Street, New York, N. Y.

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Mr. E. E. Ehrenfeld, 444 Little Building, Boston, Mass.

Wyman-Taylor-Ward Co., 403 Real Estate Exch. Bldg., Detroit, Mich.

Doermann-Roehrer Co., 318 East Third St., Cincinnati, Ohio.

James T. Winterling Co., 209 Alpine Ave., Pittsburgh, Pa.

Kemp Machinery Co., 215 N. Calvert Street, Baltimore, Md.

The W. Bingham Co., Cleveland, Ohio.

Sword Bros. Co., 625-629 Seventh St., Rockford, Ill.

The E. A. Kinsey Co., Indianapolis, Ind.

The R. C. Neal Co., 76 Pearl St., Buffalo, N. Y.

Western Iron Stores Co., Milwaukee, Wis.

R. H. Jones Co., Minneapolis, Minn.

A. E. Chadwick Co., 549 W. Washington Blvd., Chicago, Ill.

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

COMING EVENTS

September 4-9—Annual meeting of the American Chemical Society at Pittsburg, Pa. Further information may be obtained from R. S. Clark, office of the secretary, Carnegie Institute of Technology, Pittsburg, Pa.

September 11-15—Sixteenth annual convention and fourth annual exhibition of the Association of Iron and Steel Electrical Engineers at Cleveland Public Hall, Cleveland, Ohio. John F. Kelly, secretary, Empire Bldg., Pittsburg, Pa.

September 11-16—Eighth national exposition of chemical industries in the Grand Central Palace, New York City. Managers, Charles F. Roth and Fred W. Payne, Grand Central Palace, 46th St. and Lexington Ave., New York City.

September 21-23—Second annual machine tool exhibition in the Mason Laboratory, New Haven, Conn., under the joint auspices of the New Haven branch of the American Society of Mechanical Engineers and the Department of Mechanical Engineering, Yale University. H. R. Westcott, Westcott & Mapes, Inc., 207 Orange St., New Haven, Conn., is chairman of the exhibition committee.

October 2-7—Annual convention and exposition of the American Society for Steel Treating in Detroit, Mich., General Motors Bldg. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

October 25-27—Third annual meeting of the American Trade Association Executives at the Inn, Buckhill Falls, Pa.

October 26-27—Automotive production meeting of the Society of Automotive Engineers to be held in Detroit. Further information may be obtained from the Society of Automotive Engineers, 29 W. 39th St., New York City.

December 4-7—Annual convention of the American Society of Mechanical Engineers, in the Engineering Societies Bldg., 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 7-13—National Exposition of Power and Mechanical Engineering at the Grand Central Palace, New York City. Charles F. Roth, manager, Grand Central Palace, 46th St., and Lexington Ave., New York City.

March 18-24, 1923—Second general meeting of the International Chamber of Commerce in Rome, Italy. Lacey C. Zapf, secretary American Section, Mills Bldg., Washington, D. C.

NEW BOOKS AND PAMPHLETS

Radiators for Aircraft Engines. By S. R. Parsons and D. R. Harper 3rd. Technologic Paper No. 211 of the Bureau of Standards. 82 pages, 7 by 10 inches. Published by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 50 cents.

Thermal Expansion of a Few Steels. By Wilmer Souder and Peter Hidnert. Scientific Paper No. 433 of the Bureau of Standards, Washington, D. C. 16 pages, 7 by 10 inches. Published by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 5 cents.

Construction of New Type Transatlantic Receiving Sets. By M. B. Sleeper. 113 pages, 5¼ by 7¾ inches; 47 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 75 cents.

This book contains complete information, with special drawings and photographs, on the building and use of transatlantic receiving sets. The use of the loud-speaking telephone receiver is also described. The recent recommendations of the National Board of Fire Underwriters are included.

Scientific Selling and Advertising. By Arthur Dunn. 159 pages, 6 by 9 inches. Published by Harper & Bros., 333 Pearl St., New York City. Price, $3.

In this book the author describes a system of selling and advertising which has been used by him for twenty years in selling and advertising a variety of products. The book contains twenty-six chapters, the headings of some of which indicate the ground covered: The Salesman's Relation to Modern Industry; Special Characteristics of Salesmen; Responsibility of Salesmen; Essentials in Advertising; Things Necessary for Success in Selling and Advertising —Interest in your Customers, Knowledge, Faith, Self-confidence, and Method of Presentation; Better Distribution; and Application of System to Selling Different Commodities.

Factory Storeskeeping. By Henry H. Farquhar. 182 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.50.

This book outlines the principles and methods by which one of the problems of industrial management—the handling and storage of materials—may be standardized and controlled. It is a manual for those who are in any way concerned with the purchasing, storage, and disbursement of materials in a factory. The author, who is assistant professor of industrial management at the Harvard Graduate School of Business Administration, has given a great deal of study to the subject dealt with, and covers in the ten chapters of the book the various factors involved in the storing of materials—personnel; organization; balance sheets; purchasing department; traffic, receiving and inspection departments; store-room layouts; classification of materials; and accounting, inventories, and statistics.

Modern Plumbing Illustrated. By R. M. Starbuck. 407 pages, 10 by 7½ inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $5.

This fourth revised and enlarged edition forms a comprehensive work, illustrating and describing the drainage and ventilation of private dwellings, apartments, and public buildings. The latest approved methods in all branches of sanitary installation are given. The book contains seventy entirely new full-page illustrations each accompanied by several pages of descriptive matter, which form a concise treatment of each phase of the work under discussion, giving notes and practical suggestions, sizes of pipe, proper measurements for setting up work, etc. Suggestions on estimating plumbing construction are also included. The book is intended for master plumbers, architects, builders, plumbing inspectors, boards of health, boards of plumbing examiners, and for the property owner, as well as for the workman and apprentice.

Machine Tool Operation. By Henry D. Burghardt. 438 pages, 7½ by 4¾ inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $2.75.

This volume is Part II of Machine Tool Operation. Part I was published in 1919. The purpose of this book is to assist those who desire a knowledge of the principles and elementary operations of machine work. The aim has been to adapt the text to use in vocational, industrial, technical, and trade schools. Part I deals with the lathe work, bench work, and work at the forge. Part II deals with the fundamental principles of construction and operation of the drilling machine, shaper, planer, milling machine, and grinding machine. A final chapter embodying what every machinist should know concerning spur gears and bevel gears is included. The section on drilling machines covers drill press construction, drills and drilling, drill press tools and operations; the part on the shaper covers shaper construction and shaper work; the section on the planer covers planer construction and planer work; the milling machine section deals with milling machine construction, cutters and their holding devices, speed, feed, and chip, typical milling set-ups and elementary operations, the index-head and indexing operations, and spiral milling; the grinding machine section covers grinding machine construction, grinding wheels, principles and practice.

NEW CATALOGUES AND CIRCULARS

Herberts Machinery & Supply Co., Los Angeles and San Francisco, Cal. Monthly publication entitled "Herberts Machinery Topics."

B. F. Sturtevant Co., Hyde Park District, Boston, Mass. Folder entitled "Cinderless Cities and Why," describing an induced draft fan which also acts as a cinder separator.

James Clark, Jr., Electric Co., Inc., Louisville, Ky. Folder illustrating and pointing out the advantages of the Clark automatic drill—a portable electric drill embodying many new features.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Folder entitled "A Neglected Source of Economy," describing the use of refrigerated drinking water systems for manufacturing plants.

David Lupton's Sons Co., Allegheny Ave., and Agate St., Philadelphia, Pa. Catalogue 110, entitled "Steel Windows," describing the company's makes of steel windows for all classes of buildings.

Morse Chain Co., Ithaca, N. Y. Folder illustrating Morse silent chain drives and calling attention to the exhibit of the company at the American Mining Congress Exposition at Cleveland, Ohio, October 9 to 14.

Sprague Electric Works of the General Electric Co., 527 W. 34th St., New York City. Bulletin 48718, on Sprague electric dynamometer chassis test system for automobile manufacturers, service stations, and public garages.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Folder 4500, describing Westinghouse full-safety motor starters. There are four types of these starters with capacities ranging from the smallest motor up to those of 15 horsepower, 550 volts.

New Departure Mfg. Co., Bristol, Conn. Leaflets 25FE to 28FE, covering band sawing machine equipped with New Departure ball bearings; drilling machine head mounted on ball bearings; and ball bearings in multiple-spindle drill countershaft.

Samuel Harris & Co., Chicago, Ill., dealers in tools and supplies for machinists and manufacturers, have issued a booklet entitled "Harris Reminder," containing among other material an article on the history and development of the Brown & Sharpe Mfg. Co.'s precision tools.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Folder 4453, entitled "Quiet-running Gears," dealing with micarta gears, and pointing out the qualities of quietness, durability, and efficiency of these gears; also publication 4249-A, describing the company's line of insulating and soldering compounds.

Victor Tool Co., Madison and W. M. R. R., Waynesboro, Pa. Catalogue of Victor self-opening die-heads, collapsible taps, floating toolholders and nut facing machines. The catalogue is profusely illustrated with actual operation pictures, and shows clearly the application and use of the various lines of Victor tools.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue describing the LeBlond 11-inch heavy-duty rapid-production lathe. A complete description of the machine and its features, together with illustrations of some of the more important details, is given. Complete specifications and list of equipment are included.

Firth-Sterling Steel Co., McKeesport, Pa. Catalogue entitled "Blue Chip High-speed Steel," containing information on the heat-treatment of this class of steel for different uses, such as for lathe and planer tools, milling cutters, drills, reamers, punches and dies, shears, taps, etc. The catalogue also lists the standard and special sizes of steel furnished by the company.

W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill. Gear catalogue No. 24, listing the company's complete line of cast-tooth gear patterns for spur gears, bevel gears, miter gears, worm-gears, and racks and pinions. The catalogue also contains list prices for rawhide pinions as well as miscellaneous information useful when laying out gear drives or for estimating purposes.

Reliance Gauge Column Co., 6008 Carnegie Ave., Cleveland, Ohio. Catalogue entitled "Reliance Steam Specialties," containing a full description of the products of the company, with directions for their installation and care. A digest of that part of the A. S. M. E. Boiler Code applying to water columns is included. The catalogue also contains some tables useful to engineers in laying out power plant piping and in installing power plant apparatus.

Canton Art Metal Co., Canton, Ohio. Catalogue of steel factory equipment and special sheet metal work manufactured by the company, including perforated plate and expanded metal tote-boxes for shops, plain tote-boxes, nesting tote-boxes, stacking trays, chip pans, waste cans, shop barrels, tool cabinets and tool stands, factory stools and chairs, gear guards, drying ovens, tanks and tank hoods, and factory stock-room shelving and equipment.

General Electric Co., Schenectady, N. Y. Bulletin 48028, entitled "Electrically Operated Pumps," showing the feasibility of applying electric motors for driving pumps of all kinds, and pointing out the items to be considered in selecting the best type and construction of motor and control for different installations. The bulletin covers 60 pages, 8 by 10½ inches, is profusely illustrated, and contains a great deal of specific information on the subject dealt with.

Chapin-Skelton Corporation, 406-408 Ash St., Syracuse, N. Y. Catalogue of reamers, boring-bars, lathe arbors, counterbores, production tools and special machines. Among the tools illustrated and described are the Skelton patent roughing reamers, S. A. E. standard roughing reamers, inserted-blade roughing reamers, helical finishing reamers, floating holders, taper pin reamers, bridge reamers, boring-bars, toolposts, burring fixtures, mandrels, counterbores, end-mills, and spot-facing tools.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue describing the multi-cut lathe built by the company, containing a complete description of the machine together with illustrations showing the details of its construction. A number of specific examples of machining operations performed on the machine are included, showing the set-up, complete detail drawing of the work performed, and the time of operation. Instructions for setting up the machine, with tabulated information, are also included.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md. Catalogue entitled "P. M. P." (Products-Markets-Policies) containing a description of the products of the company, emphasizing their special features and advantages, and including a market analysis to indicate the approximate field for the sale of these products and details of the policies of the Black & Decker Mfg. Co., showing exactly what assistance the company is in a position to render to jobbers and dealers in selling Black & Decker products.

Alvord Reamer & Tool Co., Millersburg, Pa. Catalogue 6, covering a complete line of metal cutting tools, including high-power milling cutters in all styles and types both of standard and special design. The catalogue lists among other tools, hand reamers, jobbers' reamers, chucking reamers, shell reamers, taper reamers for various purposes, bridge reamers, countersinks, center reamers, counterbores, shell drills, twist drills, plain milling cutters, side milling cutters, keyway cutters, end-mills, angular cutters, punches and dies, taps of different types, and threading dies.